

VERTEBRATE ANIMAL PEST MANAGEMENT

Study Guide for Pesticide Application and Safety
Category 12



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STUDY GUIDE FOR VERTEBRATE ANIMAL PEST MANAGEMENT

The educational material in this study guide is practical information to prepare you to meet the written test requirements. It doesn't include all the things you need to know about this pest-control subject or your pest-control profession. It will, however, help you prepare for your test.

Contributors include the Utah Department of Agriculture and Utah State University Extension Service. This study guide is based on a similar one published by the Colorado Department of Agriculture. Materials for that guide were prepared by Colorado State University Extension Service. Other contributors include: University Extension Service personnel of California, Illinois, and Georgia, as well as the materials prepared in the previous draft by Metro-Pest Management Consultants, Inc. were utilized freely and with appreciation in preparing this study guide.

The information and recommendations contained in this study guide are based on data believed to be correct. However, no endorsement, guarantee or warranty of any kind, expressed or implied, is made with respect to the information contained herein.

Additional topics that may be covered in your examinations include First Aid, Personal Protective Equipment (PPE), Protecting the Environment, Pesticide Movement, Groundwater, Endangered Species, Application Methods and Equipment, Equipment Calibration, Insecticide Use, Application, Area Measurements, and Weights and Measures. Information on these topics can be found in the following books:

1. **National Pesticide Applicator Certification Core Manual**, Published by the National Association of State Departments of Agriculture Research Foundation.
2. **The Workers Protection Standard for Agricultural Pesticides – How to Comply: What Employers Need to Know**. U.S. EPA, Revised September 2005, Publication EPA/735-B-05-002.

These books can be obtained from the Utah Department of Agriculture or Utah State University Extension Service. Please contact your local Utah Department of Agriculture Compliance Specialists or Utah State University extension agent.

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INTRODUCTION

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STUDY GUIDE

This study guide provides information specific to the control of vertebrate animals in Utah that are common pests. Vertebrate animals include mammals, birds, reptiles, amphibians, and fish. Fish are covered in the Study Guide for Aquatic (Surface Water) Pest Control. Domestic or commensal rodents such as rats and mice are covered in the Study Guide for Structural Pest Control. This guide does not discuss the many desirable attributes of animals.

The classification of an animal as a pest is often dependent upon its relationship with humans. Problem animals are often difficult to control because of their proximity to buildings, farmsteads, homes, industrial operations, and other sites frequented by humans. Vertebrate pest control methods are generally classified under the categories of habitat

Manipulation, behavior manipulation, or population reduction.

HABITAT MANIPULATION

Habitat manipulation or modification is an effective management tool for excluding many vertebrate pests. Closing small openings in buildings can rodent proof or bat proof a structure. Installing or improving fences can exclude numerous troublesome species including snakes, skunks, and deer.

BEHAVIOR MANIPULATION

Behavior manipulation uses techniques and equipment to reduce or eliminate nuisance and/or damage by pests. Repellents, defined as chemical or physical (mechanical) deter animals by their sense of sight, smell, touch, taste, hearing, or a combination of these. Physical repellents include flashing lights, noise producing devices, electrically charged wires, scarecrows, nets, or other controls. Chemical repellents generally influence behavior through taste, smell, or touch. Chemical repellents include tacky or sticky substances placed on window ledges to discourage tree squirrels or pigeons. Other examples include the

chemical repellents for pests such as bats, rabbits, canines, and deer.

for proper use. Read and follow the label instructions.

POPULATION REDUCTION

Population reduction is achieved by direct or indirect means. Direct reduction involves artificially induced deaths and indirect reduction lowers the population through some agent or mechanism. Direct population reduction uses techniques such as toxic baits, gases, trapping, or shooting.

Populations are often reduced indirectly through habitat manipulation. Fewer animals will be produced and survive if the habitat is restricted or made less favorable to the pest species. Filling cavities in backyard trees will prevent tree squirrels from using them as nest sites. Controlling grubs in a lawn will reduce the food supply for skunks, making their presence less likely.

When the number of animal pests is small the problem can be resolved without pesticides. In situations where the pest population is high, pesticides are often the only economical and practical approach.

PRECAUTIONARY STATEMENT

All pesticides have both benefits and risks. Benefits can be maximized and risks minimized by reading and following the labeling. Pay close attention to the directions for use and the precautionary statements. The information on pesticide labels contains both instructions and limitations. Pesticide labels are legal documents and it is a violation of both federal and state laws to use a pesticide inconsistent with its labeling. The pesticide applicator is legally responsible

II. MANAGEMENT OF MAMMAL PESTS

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MAMMAL PESTS

Numerous mammalian species are in conflict with the human residents of Utah. The problems frequently involve vertebrate pests competing with people and/or livestock by feeding on forage crops such as grasses and alfalfa, feeding on or damaging trees and shrubs, and killing or harming domestic livestock. Other conflicts occur when they enter buildings, eat food or feed, and contaminate the facilities with their droppings.

Some mammals also carry diseases that are transmissible to humans and pets. In addition to mammals covered in this guide other mammals such as badgers, bobcats, beaver, mink, weasels, marmots, pronghorn, bear, mountain lion, moose, and wild horses occasionally cause problems in Utah.

Utah's wildlife, identified as big game, small game, furbearers, and nongame is under the authority of the Utah Division of Wildlife Resources. This state agency publishes annual proclamations and maintains a web site <www.wildlife.utah.gov> dedicated to the rules and regulations concerning the lawful control, trapping, and killing of wildlife.

Instructions included in the proclamations and on the website state that "A person may not engage in hunting or trapping protected wildlife or in the sale, trade or barter of protected wildlife or their parts without first having procured the necessary licenses, Certificates of Registration, permits and tags as provided in the Wildlife Resources Code and having at the same time the licenses, Certificates of Registration, permits and tags on his or her person."

BATS

BIOLOGY AND BEHAVIOR

The plain-nosed bats and the free-tailed bats are the two families of bats in Utah. The largest is the adult big free-tailed bat with a wingspan of 17 inches and a weight of less than 1 ounce. The smallest, the adult western pipistrelle, is the size of a hummingbird and weighs 1/10 ounce. The fur color of these species is a mixture of tans, browns, rusts, and black, with some white accent.

Utah bats live in and use a variety of habitats as roost sites. These roosts may include caves and mines, tree foliage, hollow trees, cracks in rock cliffs, and buildings. Most Utah bat species are year round residents of the state that hibernate during the winter. Hibernation is a special adaptation bats use to survive cold periods when

insects are not available. In late summer, bats prepare for hibernation by feeding heavily and accumulating extra body fat. Most bats are able to store enough fat to last through the hibernation period, which can last six months.

In the autumn, bats seek out cool environments, where they are able to lower their body temperature, breathing, metabolism, and blood circulation to begin hibernation. If repeatedly disturbed during hibernation, the bats may starve to death before spring. Because good hibernation sites are becoming scarce, thousands of bats of several species may gather in a single cave or abandoned mine. The average life span for a bat is 10 to 20 years. Natural enemies of bats include hawks, owls, cats, raccoons, snakes, bobcats, ringtails, and weasels.

DAMAGE

The damage caused by bats is related the animal's feces, called bat guano, and the danger



of rabies transmission. Bat guano has the potential to produce histoplasmosis, a fungus that forms on moist animal wastes. Histoplasmosis, when dry, forms a dust that if breathed into the lungs can cause flu-like symptoms in humans. Large concentrations of bat guano can also irritate the eyes and produce a mess.

The danger of a bat can bite is not in the wound it inflicts but rather the potential to transfer a fatal disease. Pets should receive their rabies shots and these animals should not be handled because a bat will bite like other wild animals.

If a bat bites a person, the bat should be captured without damaging the head, and the local health department should be contacted to have the bat examined for rabies. If the bat is confirmed rabid, the person must undergo rabies treatment.

CONTROL METHODS

Exclusion

The best long-term solution to problems with bats in the attic is exclusion. Excluding bats should not be tried from mid-June through early August, because flightless young may be trapped inside, resulting in offensive odors when they die. Bats can be excluded by plugging all holes greater than 3/8 inch with caulking, flashing, screen, fiberglass insulation, or stainless steel wool.

Before trying bat-proofing, make sure all bats are out of the building. If bats are present, leave a few small holes open and plug them a few hours after dark, after all bats have left for the evening. If all bats have not left the attic, place a commercial bat-excluder over the hole to allow exit and prevent reentry.

Repellents

Bats can be encouraged to leave attics by placing 5 pounds of naphthalene crystals or flakes per 2,000 cubic feet in the area. Place these materials in stockings or cloth so they can be removed after the bats leave. Naphthalene should not be used in human living quarters, because prolonged exposure to the vapors may be hazardous. All repellents are only temporary in effectiveness and are a waste of time if not used in conjunction with bat-proofing measures. Bright lights and drafts created in the attic also encourage bats to leave.

LEGAL STATUS

Utah law protects all species of bats. It is illegal to intentionally kill bats. Additional protection is extended to bat species on the federal endangered species list.

PRAIRIE DOGS

BIOLOGY AND BEHAVIOR

Three species of prairie dogs are found in Utah. They are the Utah prairie dog, the Gunnison prairie dog, and the white tailed prairie dog. Prairie dogs are burrowing ground squirrels that weigh 1-1/2 to 3 pounds and are 14 to 17 inches long. Their reddish fur, large eyes, short ears, and broad, round head identify prairie dogs.



Prairie dogs live in colonies, commonly referred to as prairie dog towns. Small groups, generally composed of 1 adult male, 3 adult females and 6 offspring will display territorial behavior toward adjacent groups in the town.

Prairie dogs live in burrows about 10 yards apart, 3 to 14 feet deep and 10 feet to more than 100 feet long. A crater-like mound 3 to 10 feet across and 1/2 to 1 foot high at the entrance of the burrow prevents water from rushing in and serves as a lookout station.

A density of 35 Utah prairie dog burrows per acre is common. Some burrows have 2 or 3 entrances. Prairie dogs are active only during the day. They do not hibernate, but they will stay below ground for several days during cold, cloudy weather.

Prairie dogs have 1 litter of 3 to 8 young per year, born in March or April. The gestation period is 28 to 34 days. The pups venture above ground at an age of 5 to 6 weeks and disperse in late spring, usually a distance of 2 miles or less.

Prairie dogs and their burrows serve as important hosts for numerous other animals. In Oklahoma, 89 vertebrate species were associated with prairie dog towns. Prairie dogs are an important food source for predators, including the endangered black-footed ferret, badgers, coyotes, foxes, eagles, prairie falcons, hawks, and owls. Their burrows serve as homes for burrowing owls, cottontail rabbits, rattlesnakes, and other animals.

The burrowing activity of prairie dogs decreases soil compaction, increases water intake, aerates the soil, and promotes soil formation. Prairie dogs also provide recreation for photographers, hunters, and naturalists.

DAMAGE

Prairie dogs are hosts for fleas that occasionally carry bubonic plague. Plague is transmitted to humans via fleabites. Early symptoms of plague include swollen and tender lymph nodes, chills, and fever. Early diagnosis

and treatment are imperative. When walking through suspected plague areas, individuals should apply an insect repellent to socks and pant cuffs and tuck pants inside boots.

The effect of prairie dogs on the reduction of available rangeland forage for livestock is currently unknown. Reduction can be influenced by several factors, including geographic location, rainfall, dominant grass species, and duration of prairie dog inhabitation. Recent research suggests a wide variety of effects ranging from a 20 to 30 percent reduction in available forage to an actual increase in the percent of grass species preferred by livestock.

CONTROL METHODS

Shooting

Intensive shooting of small prairie dog colonies will sometimes control their numbers because it disrupts reproductive activities and removes individual animals.

Baits

Baits for prairie dog control must be used with caution because poison grain baits can kill a wide variety of birds and mammals. Poison grain baits for prairie dog control in Utah are restricted use pesticides that include 2 percent zinc phosphide on oats or a pelleted form of oats. Poison grain bait is most effective when the prairie dog's most desirable food, green grass, has become dry and dormant.

Fall baiting generally is most successful, because prairie dogs actively eat grass seeds to build fat reserves for the winter. Spring baiting generally is less successful because pregnant females often are not above ground, weather conditions are not predictable, and bait acceptance is poor when grass starts turns green.

Poison grain baits for prairie dog control are most effective during clear, settled weather when temperatures are moderate. Rain will wash the toxicant from most bait. Zinc phosphide application is restricted to a period from July 1 through December 31; however, it is most successful when applied between September and November.

Prebaiting with untreated oats, preferably steam rolled oats, 2 to 3 days prior to baiting will increase the acceptance of treated bait and result in significantly better control. Both prebait and bait should be applied by hand on the edge of each mound where bare soil and grass interface. Do not place bait on top of the mound or down the burrow. The treated bait should be thinly scattered in a 6-inch bait spot, preferably during early morning.

Avoid placing treated bait in piles that may endanger livestock. Apply treated bait only after most of the prebait has been eaten and only to burrows where the

untreated bait was eaten. If most of the prebait is not gone after 1 day, application of both the prebait and bait should be postponed.

The amount of poisoned grain should not exceed 1 heaping teaspoon or 4 grams of zinc phosphide bait per mound. A typical prairie dog town requires about 1/3 pound of zinc phosphide bait per acre. Application of excess bait will not improve control but will increase the risk to nontarget animals. Poison grain bait should be applied only once per season, because survivors of the first treatment tend to become bait shy.

Zinc phosphide is poisonous to all animals and it should be stored away from humans and pets. Rubber gloves should be worn to avoid contact with the chemical, and extra care must be taken to avoid breathing zinc phosphide dust.

When poison grain baits are applied according to directions, they usually result in an 80 to 90 percent reduction in prairie dog numbers. Unsuccessful control generally is associated with the presence of green grass or failure to prebait.

Fumigants

Fumigants are used when additional control is required. Aluminum phosphide tablets and gas cartridges are the 2 fumigants used for prairie dog control in Utah. Aluminum phosphide tablets emit a poisonous gas, whereas gas cartridges produce a suffocating gas primarily composed of carbon monoxide. Fumigants are expensive, laborious to apply, and hazardous to wildlife. They should be used on small acreages, as follow up to poison grain baits, or on large acreages where grain baits are prohibited.

When using a fumigant as follow-up to a baiting program, treat only active mounds. This will greatly reduce the amount of fumigant used. To identify active mounds, shovel the soil or place a dry cow chip over all holes. It is important to begin treatment the next day after plugging holes, because one prairie dog will uncover several holes in 3 or 4 days.

Due to high soil moisture, fumigants are most effective when used in early spring. Also, young prairie dogs have not been born or they are still in their original burrows. After fumigants are placed in the burrow, immediately plug the opening with moist soil or a plug of the sod placed grass side down to form an airtight seal. Be careful to not cover or smother the fumigant when plugging the opening.

A wadded newspaper placed in the burrow following application of the aluminum phosphide tablets may deter prairie dogs from digging out before they die. Aluminum

phosphide appears to provide the best control when soil temperatures are above 60 degrees F. As a general rule, fumigants will not provide satisfactory control if the soil is dry.

The hydrogen phosphide gas (phosphine) produced by aluminum phosphide tablets is toxic to all forms of animal life. Exposure through inhalation produces symptoms such as a pressing sensation in the chest, dizziness, nausea, vomiting, and a rapid onset of stupor. Affected persons should be exposed to fresh air and receive immediate medical attention.

Avoid using fumigants in burrows occupied by black-footed ferrets, burrowing owls, rabbits, and other nontarget wildlife. The white droppings, pellets, and feathers found around the burrow opening identify burrows occupied by owls.

Extermination of prairie dog populations does not guarantee the recovery of productive rangeland. Mounds should be leveled and disked to speed recovery. To allow the grass and root system to recover, exclude livestock from the dog town for at least 1 growing season, and reseed the area with native grasses. Prairie dogs do not thrive in tall grass and management for grass growth can discourage reinvasion by prairie dogs.

LEGAL STATUS

At the time this publication was printed, the Utah, white tailed, and Gunnison's prairie dogs are not protected, but certain areas of the state are closed to the taking of prairie dogs. The Utah and Mexican prairie dogs are classified as threatened or endangered species. Refer to the Utah Division of Wildlife Resources for current regulations concerning the status of prairie dogs <<http://www.endangeredspecies.com/states/ut.htm>>.

POCKET GOPHERS

BIOLOGY AND BEHAVIOR

Pocket gophers are burrowing rodents, 7 to 13 inches long and weighing 3 to 14 ounces, that spend most of their lives below ground. They are named for the fur lined cheek pouches located along side of the mouth. The pockets are used to carry food. Gophers have powerfully built forequarters with large claws on their front feet, a short neck, external ears, small eyes, and lips that close behind their large incisors.

Four species of pocket gophers are found in Utah. The four species are distributed in almost entirely different areas, possibly because of different ecological requirements or competition. Plains pocket gophers are abundant in sandy and silty soils of the plains, but they are not abundant in compacted soils.

The northern pocket gopher can be found in the deep, sandy soils of the plains and in the shallow gravel of mountainous areas. It is the most common species in mountain rangelands and forests. The valley pocket gopher is found mainly in soils of warm valleys in southern Utah.

The yellow-faced pocket gopher inhabits a portion of the area in southeastern Utah where the plains pocket gopher is found. However, the yellow-faced pocket gopher is confined to drier sites or sites with soils that are less favorable for the plains pocket gopher.



Pocket gophers attain the highest densities on light textured soils with good herbage production. Shallow soils limit pocket gopher populations because of tunnel cave-in and poor insulation from summer and winter temperatures.

Pocket gophers build burrow systems by loosening the soil with their claws and incisors. Gophers then use their forefeet and chest to push the soil out of the burrow. The soil is deposited in fan shaped mounds 12 to 18 inches wide and 4 to 6 inches high.

Burrow systems consist of a main tunnel 4 to 18 inches below the soil surface and numerous lateral burrows extending from the main. Lateral burrows end with a soil mound or a soil plug at the surface. Burrows are 2 to 3 1/2 inches in diameter depending on the size of the gopher. A burrow system varies from linear to highly branched and may contain up to 200 yards of tunnels and several mounds. Mound building by a single gopher brings 1-1/4 to 2-1/4 tons of soil to the surface each year.

Pocket gophers usually breed in the spring and produce 1 litter of 3 to 6 young after a gestation period of about 20 days. Usually, only 1 adult is found in each burrow system except during breeding and while raising young. Six to 8 plains pocket gophers per acre are considered

high densities, whereas northern pocket gophers occasionally reach densities of 20 per acre. Young pocket gophers usually begin dispersing from the natal burrow in June, when about half grown.

Pocket gophers feed on roots encountered while digging, vegetation pulled into the tunnel from below, and aboveground vegetation near the tunnel. Pocket gophers prefer aboveground vegetation that is green and succulent. Pocket gophers prefer succulent forbs in spring and summer, but they also feed on grasses. Many trees and shrubs are clipped just above ground, especially under snow cover.

DAMAGE

Pocket gophers reduce the productivity of those portions of alfalfa fields and native grasslands on which they are found by 20 to 50 percent. If gophers are present on 10 percent of a field, they may reduce overall forage productivity of the field by 2 to 5 percent. Gopher mounds damage and interfere with hay harvesting equipment. Gophers sometimes damage trees by girdling or clipping stems and by pruning roots. Gophers may, at times, destroy underground utility cables and irrigation lines.

On the other hand, gophers are beneficial in several ways. Their burrowing activities increase soil fertility by adding organic matter in the form of plant materials and feces. The burrowing reduces soil compaction and increases water infiltration, soil aeration, and the rate of soil formation.

CONTROL METHODS

Exclusion

Pocket gophers can be excluded from valuable plots of ornamental trees and shrubs with a 0.25 inch to 0.5 inch mesh hardware cloth fence buried at least 18 inches. In shallow soil, the fence should be placed at least 2 feet from the nearest plants to avoid root injury. This method is of limited practicality because of expense and labor.

Cultural Methods

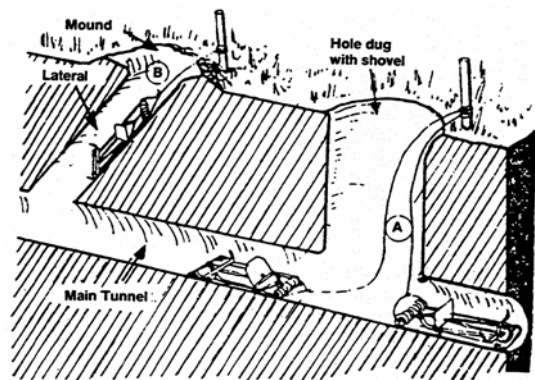
- Varieties of alfalfa with several large roots rather than a single taproot suffer less when pocket gophers feed on them.
- Rotating alfalfa with grain crops effectively controls pocket gophers because annual grains do not produce large enough roots to support gophers year round.
- Buffer strips of grain around a hay field provide unsuitable habitat and can reduce immigration of pocket gophers.

- Control of broadleaf forbs with herbicide treatments can effectively control northern and valley pocket gophers and cut damage to rangelands. This method is less effective for plains pocket gophers because they easily survive on grasses. In orchards and shelterbelts, control of forbs will sometimes limit gopher damage.
- Flood irrigation can effectively control pocket gophers especially in fields that have been leveled to remove high spots that might serve as refuges. The wet flooded soil generally prevents diffusion of gases in and out of the burrow and sticks to the pocket gopher's fur and claws creating an inhospitable environment.

Trapping

Trapping is a method of reducing pocket gopher populations on fields and removing the remaining animals after a poison control program. Body gripping traps such as the Death Clutch 1, Macabee, Victor, or Guardian Gopher Trap are available to capture gophers. Traps can be set in the main or lateral tunnel, preferably near the freshest mounds. A circular plug, sometimes a depression, in the fan shaped mound, identifies the lateral tunnel.

Probing the lateral tunnel depression will allow the tunnel direction to be determined. The plug can be dug out and a trap, secured to a chain and marker stake, can be inserted with the body gripping jaws about 6 to 8 inches into the tunnel. The chain is attached so the gopher cannot pull the trap into the tunnel and also so other animals will not be able to remove the trap if they take the gopher.



Traps can also be set in the main tunnel about 12 to 18 inches from the mound. After uncovering the main tunnel with a shovel, set 2 traps, 1 in each direction. The

tunnels can be left open or covered after setting traps. Traps should be checked twice daily since gophers often visit the traps within a few hours. If a trap is not visited within 48 hours, move it to a new location. Trapping is usually more successful in the spring and fall when gophers are actively building mounds.

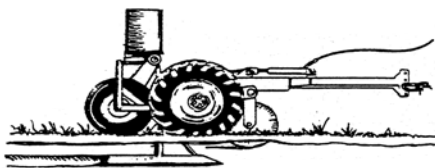
Baiting

Bait can be placed into a burrow system by hand after opening the main tunnel with a hand probe. To place bait in the burrow system by hand, locate the main by digging with a shovel 12 to 18 inches from the plug side of the mound. Place the recommended amount of bait, following label directions, in each direction of the opened main tunnel and well into the system. Close off each tunnel with sod clumps and soil so gophers do not try to close the system and cover the bait with soil.

A less time consuming baiting method involves using a pointed rod hand probe. Locate the main tunnel 12 to 18 inches from the plug side of the mound by pushing the probe into the ground. The decreased friction on the probe indicates the location of a tunnel. This type of probe can also be used with trapping to locate the tunnels.

Bait can be placed through the probe hole into the tunnel. A reservoir type bait probe dispenser is also available for poisoning gophers. Place the recommended amount of bait down each of 2 or 3 probe openings then cover the probe holes with sod.

Mechanical Burrow Builder



The burrow builder mechanically delivers poisoned bait underground to economically control pocket gophers on large acreages. A tractor pulls the burrow builder. The device consists of a knife and torpedo assembly that makes an artificial burrow at desired soil depths.

A blade cuts roots of plants ahead of the knife, a seeder assembly dispenses bait, and a packer wheel closes the furrow behind. The seeder dispenses poison baits. Burrow builders can be used successfully if the soil is not extremely dry.

To achieve good results with a burrow builder:

1. Adjust the burrow builder to build tunnels at the same depth as those built by gophers in your area so gophers intercept the tunnels.

2. Use the machine only when the soil moisture is adequate, because if the soil is too dry, the burrow may collapse, and if the soil is too wet, the slot over the tunnel may not close. Generally, the soil moisture is adequate if it is damp enough so that a compressed handful will hold its shape.
3. Space the burrows at 20 to 30 foot intervals in areas of infestation. Burrow spacing depends on gopher densities and species involved; usual spacing is 20 to 25 feet for the northern and valley pocket gophers and 25 to 30 feet for the plains and yellow-faced pocket gophers.
4. Periodically check that bait is dispensing down the tube.
5. Enclose the perimeter of the field with artificial burrows to prevent reinvasion.
6. Follow directions provided with the burrow builder machine. Recommended application rates of 1 to 2 pounds per acre of 0.35 to 0.5 percent strychnine provides 85 to 95 percent control.
7. Any spilled bait should be cleaned up and disposed of properly. Any dead gophers found above ground should be buried to reduce hazards of secondary poisoning to predators and scavengers.
8. To improve the effectiveness of this control method, harrow the field a week after treatment to level mounds, then retreat by hand and/or trap at new mounds.

Baits

Baits registered for pocket gophers control in Utah include strychnine from 0.35 to 0.5 percent, zinc phosphide at 2 percent, and chlorophacinone at 0.005 percent. Some of these are restricted use pesticides and some are general use.

Baits formulated on milo, barley, or wheat are widely used toxicants. They are usually labeled as restricted use pesticides because they are highly toxic and potentially hazardous to all wildlife. Underground baiting presents minimal hazards to nontarget wildlife, but any grain spilled on the surface may be hazardous to ground feeding birds or mammals.

Fumigants

Several types of materials and devices are available for fumigating pocket gophers. Fumigants are not very successful for controlling pocket gophers because either the gophers sense the poisonous gas and plug the tunnel or the soil is too dry and the fumigants do not diffuse properly.

LEGAL STATUS

State or federal laws do not protect gophers when they are on agricultural lands or private property.

VOLES

Voles, also referred to as meadow mice, are small mouse to rat sized rodents. They are pudgy, with blunt faces, small eyes, short ears, short legs, and a short tail. Eight species of voles are widely distributed throughout the various ecosystems of Utah.

DESCRIPTION AND BEHAVIOR

Voles are adapted to digging and build many tunnels and surface runways with numerous burrow entrances. They are active throughout the day and do not hibernate in winter. Vole activity is closely tied to the grasses that are their primary food.

Voles can be reproductively active throughout the year. The average number of litters varies from 3

To 12, with the number of young varying from 3 to 6 per litter. Due to their active nature during winter, they are a valuable food source for owls, foxes, coyotes, and other predators.

DAMAGE

Vole cause many types of damage. They feed on and girdle nursery stock, fruit trees, and ornamental plantings. They damage lawns by building runways under the snow. They also damage root crops, bulbs, and tubers. Most damage by voles occurs under the snow during the winter.

CONTROL METHODS

Habitat Management

Eliminating ground cover of weeds and tall grasses through repeated mowing, tillage, and herbicide application will reduce vole populations and the damage they cause.

Exclusion

Voles can be excluded from young trees and shrubs by encircling the plants with 0.25 inch hardware cloth or plastic mesh cylinders. These barriers should be at least 12 inches above expected snow depth and 3 to 6 inches below the soil surface.

Repellents

A few repellents including thiram and capsaicin are manufactured to protect trees, shrubs, and vegetable crops from voles. Unfortunately, very little data is available on the effectiveness of repellents for deterring damage by voles.

Trapping

Mousetraps placed perpendicular to runways and baited with peanut butter, oatmeal, or apple slices can be used to remove voles from backyard lawns.

Baits

Utah has 2 poison baits registered for the control of voles. They are zinc phosphide at 2 percent and diphacinone. Zinc phosphide baits are restricted use products labeled for use in orchards, groves, nurseries, ornamental and nonbearing fruit trees, grapevine yards, and noncrop areas such as lawns, ornamentals, golf courses, parks, and nurseries.

Most of the zinc phosphide products are labeled for hand or broadcast baiting in orchards, groves, nurseries, and around ornamental and nonbearing fruit trees. In noncrop areas, these products are labeled for hand baiting in conjunction with prebaiting.

Prebaiting consists of scattering untreated oat groats, rolled oats, or barley 2 to 4 days before placing the toxic bait. Prebaiting has been shown to provide more consistent acceptance of bait by target species.

Hand baiting around trees generally consists of placing 1 teaspoon of bait at 2 to 4 locations around each tree in surface traps or at the mouth of holes leading to underground burrow systems. In noncrop areas, hand baiting generally consists of placing 1 teaspoon of bait around each active burrow or runway. Broadcast baiting generally consists of spreading 4 to 10 pounds of bait per acre with a cyclone seeder or by hand.

Zinc phosphide baits are limited to only certain species of voles. Zinc phosphide bait should not be applied to bare ground areas without vegetation, or in piles because of the hazards to birds. Zinc phosphide baits also should not be applied to crops destined for use as food or feed. Zinc phosphide baits can be applied to orchards and groves only during the dormant season after harvest.

Zinc phosphide is poisonous to all animals and it should be stored away from humans and pets. Rubber gloves should be worn to avoid contact with the chemical and extra care must be taken to avoid breathing zinc phosphide dust.

Diphacinone (Ramik) is poison grain bait labeled for aerial or ground broadcast baiting of meadow voles. Rubber gloves should be worn when applying this product. Do not graze beef or dairy cattle in treated fields. Do not use hay from treated fields as feed or bedding.

LEGAL STATUS

Voles are classified as nongame mammals and can be controlled when causing damage. Contact the Utah Division of Wildlife Resources regarding the impact on possible nontarget or protected animals.

GROUND SQUIRRELS

BIOLOGY AND BEHAVIOR

Ground squirrels average 10 to 15 inches in length and weigh 10 to 18 ounces. They generally are a brownish, smoke gray color. Ground squirrels are found in the northern 1/3 of Utah from 5,000 feet elevation to above timberline.

Ground squirrels prefer grasses but also eat forbs and shrubs. They build underground burrows in which to live. They enter these burrows in late August to early September to hibernate and stay there until January to March. Two to 10 young are produced per litter. The young are weaned at about 5 weeks, and they are above ground foraging by June.

DAMAGE

Ground squirrels compete with livestock for forage and can destroy food crops. The mounds of dirt that the squirrels excavate to build burrows can damage haying equipment. Their burrows also cause damage to grasslands, golf courses, and lawns. Ground squirrels can act as carriers of bubonic plague.

CONTROL METHODS

Exclusion

In most cases exclusion is impractical for controlling problems with ground squirrels because they can dig under or crawl over most fences.

Trapping

Wooden base, snap-type traps and box traps placed near burrows and baited with peanut butter, rolled oats, fruits, or vegetables can be used to remove ground squirrels from small areas.

Shooting

Although it is time consuming, persistent shooting can remove ground squirrels from small areas.

Baits

Many grain baits are registered for control of ground squirrels in Utah. Many of these are restricted use pesticides. Zinc phosphide baits are restricted use products labeled for use on rangelands, lawns, ornamentals, golf courses, parks, nurseries, and right-of-ways along roads and transmission lines. Use on rangelands is generally restricted by the manufacturer to 1 application per year during July to December or April to June.

Zinc phosphide is poisonous to all animals and it should be stored away from humans and pets. Zinc phosphide can be absorbed in small amounts through the skin of humans. Rubber gloves should be worn to avoid contact

with the chemical and extra care must be taken to avoid breathing zinc phosphide dust.

Diphacinone (Ramik) is poison grain bait labeled for control of ground squirrels and is not a restricted use pesticide. This product can only be used in bait stations. Rubber gloves should be worn when handling this product.

Fumigants

Aluminum phosphide tablets and gas cartridges are registered as burrow fumigants for ground squirrels. Poison gasses are best suited for use on small acreage because of the comparatively large amount of labor and expense involved.

Fumigation can be difficult because ground squirrel burrow systems are often complex and have several openings. When fumigating, seal all burrow entrances with tamped soil. Fumigants work most effectively when soil moisture is sufficiently high to prevent the gas from dissipating into the earth.

LEGAL STATUS

Local laws or regulations should be consulted before undertaking lethal control.

SKUNKS

BIOLOGY AND BEHAVIOR

Skunks are members of the weasel family and possess one of the key family characteristics, scent glands. The 2 species of skunks presently inhabiting Utah are the striped and spotted skunk. Both are omnivorous, their diet varying from insects, vegetation, and small rodents to bird eggs and garbage. Both species have 5 toes and claws on their front and hind feet that are adapted for digging.



Skunks generally den in burrows of other animals, rock crevices, brush piles, or spaces under buildings, but they

will sometimes dig their own burrows. Their home range averages 0.5 to 1.5 square miles but may increase up to 5 square miles during the breeding season.

Skunks are nocturnal, reclusive animals. Extra caution should be used if a skunk is encountered during the daytime or it is extremely aggressive. This abnormal behavior may be an indication that the animal is rabid. Studies suggest that the occurrence of rabid skunks is highest during the breeding and parturition periods.

Striped skunks can be found throughout Utah. They are similar in size to a house cat, weighing 4 to 10 pounds. Their bodies are black, except for a white stripe on the forehead and a wide white area at the nape of the neck that divides into a "V" and runs along the back.

Spotted skunks, although found in the Great Plains, are primarily seen in the mountains and canyons of Utah. They weigh only 0.8 to 2.2 pounds. The body of a spotted skunk is black, with a white spot on the forehead and under each ear. They have 4 to 6 broken stripes on the back and sides and a white-tipped tail.

Skunks usually breed once a year, in February or March, and bear young in early May. Litter sizes vary from 2 to 10, depending on the species and age of the female. About 2 to 4 weeks after birth, the kits' eyes open. Kits are able to spray musk about 45 days after birth.

Bobcats, coyotes, great horned owls, and other animals prey on skunks, but not as a primary food source. Humans are the main predators of skunks. Skunks are harvested for their fur and eliminated when they are pests. Although skunks eat insects and rodents, they are pests when their activities conflict with human activities.

DAMAGE

Skunks may dig holes under buildings or obtain access through foundation openings. This situation is unfavorable because of the possible smell and because they are a major host for rabies.

Skunks also may cause damage by digging in lawns, gardens, and golf courses while looking for grubs. This digging usually results in small 3 to 4-inch cone shaped holes or patches of upturned earth.

Skunks eat fruits and vegetables, prey on poultry and eggs, and disturb beehives. In areas where nesting cover has been greatly reduced by agricultural practices, skunks can have a significant impact on waterfowl and game bird populations by preying on nests and eggs.

If bitten or scratched by a skunk, wash the wound with warm soapy water and rinse thoroughly. Any bite or scratch by wildlife and cats or dogs has the potential of causing disease. Seek medical attention if bitten or

scratched. If a pet animal bites or is bitten by a skunk immediately contact a veterinarian for advice.

Unless surprised suddenly, skunks exhibit obvious warning signals before they spray; they arch their backs, stamp their front feet, and shuffle backwards. The tail is then raised, the body bent into the U-shaped position and the musk released. This substance is a sulfur alcohol compound and can be extremely nauseating. Severe burning, tears, and temporary blindness for 10 to 15 minutes may occur if the musk enters the eyes. Rinsing the eyes with water will reduce the discomfort.

Neutroleum alpha is one of the best chemicals to help eliminate odors on pets, people, clothing, or residential areas that have been sprayed. Neutroleum alpha is contained in some commercial odor control products that can be bought at hospital supply stores and some drug and pet supply stores. Diluted solutions of ammonia, chlorine bleach, tomato juice, or vinegar may help eliminate odors.

CONTROL METHODS

Prevention

The best control for skunk problems is preventive measures such as removing lumber and junk piles, sealing off openings, storing garbage in tightly sealed cans, and cleaning up pet foods. Insecticides can be used to control grubs in turf, preventing damage by skunks. Elevating beehives about 3 feet above the ground and using a sheet of metal to prevent climbing will make them inaccessible to skunks.

If a skunk is found under a building, it is possible to encourage the animal to depart by placing generous amounts of mothballs, naphthalene flakes, or paradichlorobenzene crystals in cloth bags or cloth soaked in ammonia, or possibly a noisy radio. The bags or containers with these items can be connected with a string to allow ease of removal after the skunk vacates.

To determine if a skunk has vacated, sprinkle the entrance area with flour to make the direction of the tracks visible. Since skunks are nocturnal the area should be checked a few hours after dark. Once the animal has departed the entrance should be sealed to prevent further occurrences.

In some instances, preventive methods may not be sufficient, and elimination of the skunk may be necessary. According to Utah Division of Wildlife regulations, a permit is not necessary to kill skunks for safety and property protection on private lands. A permit is required if the hide is to be sold.

Trapping

In urban areas, skunks can be captured and removed. A state statute prohibits relocating skunks because of the possibility of introducing rabies into an unaffected area. Captured skunks must be destroyed.

Shooting

Skunks may be shot in rural areas, but not near buildings or any area of public concentration. Shooting is discouraged, because the skunk often will release musk.

LEGAL STATUS

Striped skunks may be killed in Utah any time without a license, using legal methods. Spotted skunks may be killed when they are creating a nuisance or causing damage. However, their skins or glands may not be sold or traded except by a person with a Utah furbearer license. Trapping and shooting restrictions also may apply within city limits and around livestock and other structures. Utah law prohibits possessing live skunks without a permit.

MUSKRATS

BIOLOGY AND BEHAVIOR

The range of the muskrat extends across most of North America. The muskrat spends its life in aquatic habitats and is well adapted for swimming. Its large hind feet are partially webbed and its laterally flattened tail is almost as long as its body. The muskrat has a stocky appearance, with small eyes and very short, rounded ears.



Its front feet are smaller than its hind feet and adapted primarily for digging and feeding.

The overall length of adult muskrats is usually from 18 to 24 inches. Large males, however, will sometimes be more than 30 inches long, 10 to 12 inches of which is the laterally flattened tail. The average weight of adult muskrats is from 1.5 to more than 4 pounds. The color of the belly fur is generally light gray to silver to tan, and

the remaining fur varies from dark tan to reddish brown, dark brown, and black.

Muskrats can live where water and food are available year round. In shallow water areas with plentiful vegetation, they use plant materials to build houses, generally conical in shape. Elsewhere, they prefer bank dens and in many habitats they build both bank dens and houses of vegetation.

Muskrats are mainly herbivores. They will eat almost any aquatic vegetation as well as some field crops grown adjacent to suitable habitat. Although primarily herbivores, muskrats will also feed on crayfish, mussels, turtles, frogs, and fish.

Muskrats generally have a small home range and are rather territorial. During breeding seasons some dispersal is common. Dispersal of males, along with young that are just reaching sexual maturity begins in the spring. The availability and accessibility of food impact population levels.

Both male and female muskrats become more aggressive during the breeding season in defending their territory. Litters may contain as many as 15 young, but generally average between 4 and 8. Young may be produced any month of the year.

DAMAGE

Muskrats are hosts to large numbers of endoparasites and ectoparasites. They serve as carriers for a number of diseases, including tularemia, hemorrhagic diseases, leptospirosis, ringworm disease, and pseudotuberculosis. Most common ectoparasites are mites and ticks. Endoparasites are predominantly nematodes, cestodes, and trematodes.

Burrowing activity is the source of the greatest damage caused by muskrats. They damage pond dams, floating Styrofoam marinas, docks and boathouses, and lakeshores. In waterfowl marshes, muskrat population eruptions can result in the virtual elimination of aquatic vegetation in large areas. In aquaculture reservoirs, muskrats cause damage by burrowing into levees or pond banks.

One way to observe early burrowing in farm ponds or reservoirs is to walk along the edge of the dam or shorelines when the water is clear and look for runs or trails from just below the normal water surface to as deep as three feet. If no burrow entrances are observed, look for tracks

Or droppings along the bank, on logs, or other structures a muskrat can easily climb upon. If the pond can be lowered 1.5 to 3 feet each winter, muskrat burrows will

be exposed, just as they would be during extended droughts.

Where damage is occurring to a crop, plant cutting is generally evident. In aquaculture reservoirs, generally maintained without lush aquatic vegetation, muskrat runs and burrows or remains of mussels, crayfish or fish, along with signs of tracks or droppings are present.

CONTROL METHODS

Exclusion

In some situations, muskrats can be excluded or prevented from digging into farm pond dams through stone rip-rapping of the dam. Other methods of exclusion can include the use of fencing in certain situations where muskrats may be leaving a pond or lake to take garden plants or crops.

Cultural Methods

The best ways to modify habitat are to eliminate aquatic or other suitable foods eaten by muskrats and where possible, to build farm pond dams to previously suggested specifications. If farm pond dams or levees are being damaged, one of the ways that damage can be reduced is to draw the pond down at least 2 feet below normal levels during the winter. Then fill dens, burrows and runs and rip-rap the dam with stone. Once the water is drawn down, trap or otherwise remove all muskrats.

Frightening Devices

Gunfire will frighten muskrats but it is not effective in scaring the animals away from occupied habitat.

Baits

A bait restricted use pesticide registered for muskrat control is zinc phosphide. Follow the zinc phosphide label with respect to muskrats.

Some states have obtained state registrations for use of anticoagulant baits such as pivalyl, warfarin, diphacinone, and chlorophacinone. These materials have proven effective, species selective, practical, and environmentally safe in field applications to control muskrats. Apparently there is not sufficient demand or research available to consider federal registration of anticoagulants for muskrats.

Trapping

More traps have probably been sold to catch muskrats than for any other furbearing species. A number of innovative traps have been built for both live trapping and killing muskrats, such as barrel, box, and stovepipe traps.

The most effective and commonly used types of traps for muskrats are leghold types and comparable coil spring traps. Each type has places and situations where they are more effective. The most effective sets are those placed

in runs or trails where the muskrat's hind feet scour out a path into the bottom from repeated trips into and out of the den.

Shooting

Where it can be done safely, shooting may eliminate 1 or 2 individuals in a small farm pond.

Other Methods

In situations where more extensive damage is occurring, it may be useful to employ an integrated pest management approach. This includes modifying the habitat by removing available food or vegetation, coordinating efforts to reduce the breeding population while muskrats are concentrated in overwintering habitat, and using a combination of baits and trapping.

LEGAL STATUS

Refer to the annual Furbearer Proclamation published by Utah Division of Wildlife Resources concerning the taking of muskrats.

RABBITS

BIOLOGY AND BEHAVIOR

In Utah there are three species of rabbits and three species of hares. Cottontail rabbits are smaller than jackrabbits, their ears are shorter, and the hind feet are noticeably smaller. The desert cottontail, the mountain cottontail and pygmy rabbit make up the rabbit group. The hares consist of the snowshoe hare, the black tailed jackrabbit, and the white tailed jackrabbit.

Hares live above ground and rabbits live in burrows underground. At birth the offspring of hares are open-eyed and furred, while rabbits produce closed eye young that are furless at birth.

DAMAGE

Rabbit and hares damage trees, shrubs, and shelterbelt plantings by clipping stems, buds, and small branches and by girdling larger trees. Damage occurs primarily during the fall and winter, especially when snow cover is present. Young trees are susceptible to rabbit until their smooth, thin bark becomes thick and rough with age.

CONTROL METHODS

Fences

Rabbits and hares can be excluded from gardens and small plantings by erecting a 2-foot tall mesh wire fence. The bottom portion of the fence should be secured to the

ground or buried a few inches to prevent the animals from crawling under. Cost and maintenance of this fence generally preclude its use in shelterbelts, windbreaks, and other large areas.

Tree Protectors

Tree protectors are one of the best solutions for rabbit damage. Various types of plastic, wire, paper, and tinfoil protectors can be bought or made at home. The protectors should be tall enough to protect trees 12 to 18 inches above expected snow depths. Poultry wire can be used to build cylinders to protect young trees.

Habitat Alteration

This can provide long term nonlethal control of rabbit damage. Removing brush piles, weed patches, junk piles, and other dense cover adjacent to tree plantings where rabbits live and hide can provide excellent control. Since rabbits tend to avoid open areas to escape natural predators, mowing or cultivating grass and weeds in tree plantings can reduce damage.

Repellents

Repellents can provide seasonal control of rabbit damage. However, if no alternative foods are available, repellents may fail to provide protection. Repellents can be classified as area involving odor or contact involving taste. Area repellents, which include ammonium soaps of higher fatty acids, bone tar oil, and other natural substances, are used during the growing season.

Thiram, one of the safest and most effective contact repellents, generally is used during the dormant season. Since thiram is water soluble, a chemical sticker should be added to the application mixture. Normally, one application of thiram will last the entire dormant season. Ammonium soaps of higher fatty acids are applied more often, especially after rains.

Contact repellents applied during the growing season need to be reapplied as new growth emerges. Repellents can be brushed, sprayed, or dipped onto the plants. Repellents should be applied 18 to 24 inches above the expected snow depth. Follow label directions closely when handling and storing repellents. Most repellents are not designed for use on plants grown for human consumption.

Removal

Rabbits can be removed by hunting and trapping. Hunting may effectively reduce the rabbit population and lessen the damage. Hunting generally is least effective where there is ample hiding cover.

Trapping is one of the best ways to reduce rabbit problems in urban areas. Several types of wooden and wire live traps are available from garden centers, hardware stores, and seed catalogs. Wire traps are more

effective when the sides are covered with canvas. Traps should be placed close to cover where rabbits feed and rest.

During the winter, the trapdoor should be placed away from prevailing winds to prevent leaves and snow from entering. Traps can be baited with corn, dried apples, dried leafy alfalfa, or clover during winter. During summer months apples, carrots, and cabbage work well, but they become mushy during the winter. Traps should be checked daily to replenish the bait and remove trapped rabbits. Captured rabbits should be released several miles from the plantings. Jackrabbits do not usually enter wire box traps. They can be captured using large funnel traps placed in travel lanes.

LEGAL STATUS

With the exception of jackrabbits, Utah rabbits are classified as game animals and can be hunted during the season with an appropriate license. Jackrabbits are considered nongame animals in Utah and may be hunted without a license year-round. Consult with the Utah Division of Wildlife Resources to determine the legal status and season to hunt rabbit.

TREE SQUIRRELS

DESCRIPTION AND BEHAVIOR

Tree squirrels belong to the rodent family and Utah has the Albert squirrel and the pine squirrel. The pine squirrel is also known as the red squirrel or the chickaree. Tree squirrels are seldom found far from forested or wooded areas.



Tree squirrels feed on a variety of materials including fruits, bark, leaves, fungi, insects, bird eggs, and occasionally other small animals. Tree squirrel diets vary by species and are determined by their habitat and season of the year. They do not hibernate but tend to store great quantities of food during the winter months.



DAMAGE

Tree squirrels are a nuisance and cause damage when they use buildings for nesting sites and food storage or gnaw into attics to take up residence. They often gain access through vents, broken windows, knotholes, and construction gaps under eaves and gables. Occasionally, the chimney and fireplace provide an entry route.

Some have a remarkable ability to destroy wooden shakes and shingles. The amount of structural damage may at times be severe. They can be especially destructive to cabins that are vacant during part of the year, since they are free to continue their activities until the owners return. Garages, barns, stables, tool sheds, and other buildings often serve as homes for tree squirrels.

Rarely do tree squirrels take up residence in a building without being seen or leaving evidence. The typical evidence of tree squirrels includes droppings, gnawed holes, nest materials, food stores, shells, hulls, pits, and other food remnants. If squirrels are in the attic or garage, even if not visible, their movement can be heard.

CONTROL METHODS

Exclusion

Exclusion or rodent proofing is the best solution to squirrels gaining access to dwellings. Most entry points will be above eye level, but exceptions do occur. Sheet metal or wire hardware cloth is most often used to close openings. Take care in closing all possible entry routes so that a squirrel is not trapped inside.

Trapping

If the population of tree squirrels must be reduced, live trapping is most often considered the method of choice. If squirrels are entering the premises via overhead routes such as trees or

Power lines, traps placed on rooftops or secured to limbs may be most effective. For best results, traps should be prebaited for several days with the doors secured in the open positions. When the bait is readily taken the traps should be rebaited and set.

A wide variety of baits including peanut butter, peanuts, walnuts, pecans, acorns, sunflower seeds, and raisins are effective. If squirrels manage to escape before the trap door completely closes, they may become trap shy and avoid reentering traps for extended periods.

Live catch traps should be checked at least once daily, preferably several times a day, to remove squirrels or to release other animals accidentally captured. Since tree squirrels occupy habitats favorable to many bird species, birds with a liking for the bait may also enter the traps. Captured birds should be released immediately and if birds are regularly captured, the traps should be moved to other locations.

Repellents

Naphthalene, also known as mothballs, may temporarily discourage squirrels from entering attics and other enclosed spaces. Placing mothballs in stockings and hanging them in the attic will repel squirrels. Once squirrels have been repelled squirrel proof every opening. Remove tree branches that may give squirrels access to the roof and upper stories of buildings. Cone shaped metal guards or sheet metal cylinders 2 feet high can be placed around tree trunks adjacent to buildings, but they are ineffective if nearby trees allow access.

LEGAL STATUS

Check with the Utah Division of Wildlife Resources concerning the hunting or killing of squirrels. It is illegal to shoot an Albert squirrel and tree squirrels problems frequently occur in residential areas where other restrictions apply.

PORCUPINES

BIOLOGY AND BEHAVIOR

In Utah, porcupines occur throughout the mountains and on woodlands of the state. The porcupine is heavy-bodied, brown to black in color, and has a small head, short legs, and a short, thick tail. Its sharp, barbed quills, 1-1/4 to 4 inches long, cover most of the upper body surface and the tail. Only the face, the under parts of the body and the tail are without quills. The quills can be raised and lowered at will but cannot be thrown, although they do come out easily.

When disturbed, the porcupine will raise its quills and take a defensive stand. It may whirl or lunge at its opponent, and any attacker will receive a sharp slap from the porcupine's tail. The barbed quills are driven into the flesh of the attacker, pulling free of the porcupine. The victim's own movements further embed the quills. This results in intense irritation and even death if the quills that pierce the nose, mouth, tongue, or other areas around

the head are not removed. The affected parts may become infected and swollen.

Porcupines normally sleep in dens or trees during the daytime and do most of their moving and feeding at night. The ears are small and almost hidden in the fur. Adults weigh 10 to 20 pounds or more and measure 2 to 3 feet long.

Porcupines reproduce once a year, giving birth to a single offspring in the spring. On rare occasions, twins are born. For a rodent the 7-month gestation period is unusually long. The young rely on their mother for a very brief period following birth.

Excellent climbers, they spend considerable time in trees, especially in winter. In summer, they have been known to travel several miles from the nearest forest to feed in open meadows and fields and along the banks of streams or lakes. The porcupine makes its den in hollow trees or logs, crevices of rocky ledges, or beneath buildings, if it can gain access.

Signs of porcupines are fairly easy to detect. In snow, they leave a trough-like trail about 10 inches wide. In soft soil or mud their tracks tend to toe in and impressions from the long claws are often evident.

Quills are commonly found in feeding areas but appear also along trails. The droppings measure 0.75 inch long and 0.5 inch in diameter and are generally abundant in areas where they feed and near their dens. In winter, the droppings look like compressed sawdust or excelsior from feeding on bark and twigs. In summer, the droppings may be harder to identify, because more succulent vegetation is being consumed.

In winter they feed primarily on the inner bark, cambium, and phloem tissue of a wide variety of forest trees, including ponderosa pine, pinon pine, cottonwood, spruce, elm, and poplar.

In spring, they may eat flowers, buds, and young leaves of trees. They eat a wide variety of plant foods, including some cultivated crops or home gardens, especially if they are near forested or wooded areas.

DAMAGE

Damage to trees from bark gnawing around buildings or objects that contain salt can quite easily be identified as the work of porcupines. Porcupines sometime invade landscaped yards and family fruit and vegetable gardens and eat a wide variety of succulent plants.

Porcupines near homes, summer cabins, logging camps, campgrounds, and other outdoor recreation areas can become troublesome. They gnaw the wooden underpinnings of buildings and even the siding or

doorframes of buildings. They have a particular liking for some types of plywood, apparently because of the glue used in the laminating process.

This animal is attracted to human habitats because of its strong craving for salt. Porcupines will chew or gnaw on tool handles, wooden wheelbarrow handles, boat oars, porch furniture,

Toilet seats, saddles, or anything else that may contain traces of salt from perspiration or other sources. Porcupines are regarded as an attractive nuisance to dogs. Inexperienced dogs may end up with a mouth and nose full of quills that a veterinarian may have to remove.

Porcupines are known to harbor some diseases, such as Colorado tick fever, which can infect humans, but close contact between porcupines and man is relatively uncommon. As a result, porcupines are not considered a significant threat to public health.

CONTROL METHODS

Exclusion

Constructing barriers or altering structures can exclude porcupines. Sheet metal or heavy wire mesh will discourage them from gnawing on building timbers or siding. We know of no repellent that will effectively prevent a porcupine from gnawing at favorite spots. Electric fences have been used, but many situations do not lend themselves to that approach.

Trapping

Live-catch traps are effective around buildings and gardens, if placed along routes the animals use in entering or leaving the area. Place the traps directly in their trail.

Handmade box traps, about 12 to 15 inches square and 36 inches long, are effective, as are Tomahawk and Havahart live traps. They can be baited with a salt soaked rag, apples, or carrots.

In some situations, bait acceptance is improved if freshly sectioned apples are sprinkled with salt.

Small amounts of the bait should be placed outside the trap to entice the animal inside. Wire wings, about 2 or 3 feet long, made of chicken wire and attached on each side of the trap, will make the trap more effective by guiding



the animal inside. Steel leg hold traps, sizes #2, #3, or #4, can be used to catch porcupines away from urban areas. Cubby sets with salt bait and trail sets near dens are effective.

Shooting

Shooting will eliminate the problem animal but it will not prevent a recurrence of other porcupines.

LEGAL STATUS

Porcupines are considered nongame animals and are not protected in Utah.

COYOTES

BIOLOGY AND BEHAVIOR

The coyote and its relatives have been subjected to guns, traps, and poisons for many years and they continue to live in close proximity to humans. Coyotes can be very brave in their attempts to get food. Daylight raids are not uncommon; however, the usual suburban coyote moves under the cover of darkness, taking advantage of the situation.

The chief food of coyotes includes rabbits, ground squirrels, gophers, meadow mice, deer and antelope fawns, fruits, insects, and livestock. Coyotes generally make their dens by enlarging an existing burrow by digging. An average litter consists of 6 pups born in the early spring. The most significant enemy of the coyote is the human.

DAMAGE

The coyote eats fruits, grasses, vegetables, insects, rodents, deer, and small mammals. In addition coyotes are also predators of domestic livestock, specifically sheep and goat, they present a danger to pets such as dogs and cats, and there are records of coyotes attacking small children.

CONTROL METHODS

Exclusion

Normally, coyote problems are relatively minor and are often the result of an individual making repeated attempts to get at some source of food. Exclusion by fencing, yard lights, and watchdogs are effective, but not always successful, methods of discouraging coyotes.

Trapping

Leghold traps and snares set by an experienced person can catch the offending coyote. These methods are not without the risk of catching a dog or cat.

LEGAL STATUS

Coyotes are not protected in Utah. A permit is not required and there is no closed season.

FOXES

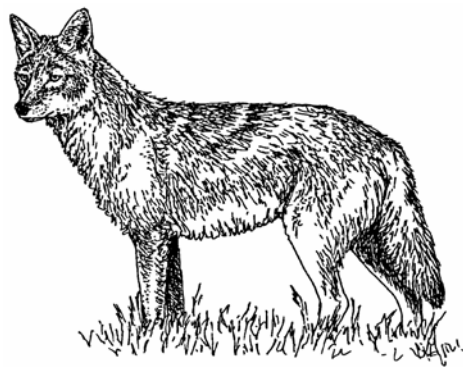
BIOLOGY AND BEHAVIOR

The red fox is the most common of the foxes native to North America. It is doglike in appearance, with an elongated, pointed muzzle and large pointed ears that are usually erect and forward. It has moderately long legs and long, thick, soft body fur with a heavily furred, bushy tail. Typically, foxes are colored with a light orange-red coat, black legs, lighter colored underfur, and a white-tipped tail. The fox weighs about 7.7 to 15.4 pounds and is found over most of North America.

The fox is adaptable to most habitats within its range but usually prefers open country with some cover. Foxes have demonstrated their adaptability by establishing breeding populations in many urban areas of the United States.

Foxes are opportunists, feeding mostly on rabbits, mice, bird eggs, insects, and native fruits. Foxes usually kill animals smaller than a rabbit, although fawns, pigs, kids, lambs, and poultry are sometimes taken. Foxes sometimes kill more than they can eat and bury food in caches for later use. Foxes feed on animal carcasses at times.

Mating in foxes normally occurs from mid-January to early February. Fox pups can be born from March to



May. Foxes generally produce 4 to 9 pups. Foxes disperse from denning areas during the fall months and establish breeding areas in vacant territories, sometimes dispersing considerable distances.

Foxes are most active during the early hours of darkness and very early morning hours. They do move about during the day, however, especially when it is dark and overcast.

Foxes are solitary animals except from the winter breeding season through midsummer, when mates and their young associate closely. Foxes have a wide variety of calls. They may bark, scream, howl, yap, growl, or make sounds similar to a hiccup. Red foxes may dig their own dens or use abandoned burrows.

DAMAGE

Foxes prey on pheasants, waterfowl, other game birds, and small game mammals. Turkeys raised in large range pens are also subject to damage by foxes. Losses may be heavy in small farm flocks of chickens, ducks, and geese. Foxes also kill young pigs, lambs, and small pets.

Rabies outbreaks are most prevalent among red foxes in southeastern Canada and occasionally in the eastern United States. The incidence of rabies in foxes has declined substantially since the mid 1960s for unexplained reasons.

Damage can be hard to detect because the prey is usually carried from the kill site to a den site or uneaten parts are buried. Foxes usually attack the throat of young livestock, but some kill by inflicting multiple bites to the neck and back. They generally prefer the viscera and often begin feeding through an entry behind the ribs. Foxes will also scavenge carcasses, making the actual cause of death hard to determine.

CONTROL METHODS

Exclusion

Build net wire fences with openings of 3 inches or less to exclude red foxes. Bury the bottom of the fence 1 to 2 feet with an apron of net wire extending at least 12 inches outward from the bottom. A roof may also be necessary because some foxes will climb a fence. Electric fences or a combination of electric and wire fences is also effective.

Cultural Methods

The protection of livestock and poultry from fox depredation is most important during the spring denning period, when adults are actively acquiring prey for their young. Foxes often den close to human habitation. The elusive nature of fox can often result in their dens going unnoticed until excessive depredations have occurred.

The practice of shed lambing and farrowing in protected enclosures can be useful in preventing fox depredation on young livestock. Also, removal of livestock carcasses from production areas can make these areas less attractive to predators.

Frightening Devices

Frightening devices provide only temporary reduction in predator activity because fox readily adapt to noise devices. Also a flashing light, rotating beacon, or strobe

light can offer temporary protection for enclosures housing livestock or poultry.

When properly trained, some breeds of dogs have been useful in preventing predation on sheep. The effectiveness of dogs depends on the training and the individual disposition of the dog.

Toxicants

A sodium cyanide mechanical ejection device is registered for control of red and gray foxes nationwide by USDA-APHIS-ADC personnel and in some states by certified pesticide applicators.

Trapping

Trapping is a very effective and selective control method. Trapping by inexperienced people may serve to educate foxes, making them very hard to catch, even by experienced trappers. Traps suitable for fox are the No. 1-1/2, 1-3/4, and 2 double coil-spring trap and the No. 2 and 3 double long-spring trap.

Proper set location is important when trapping foxes. Sets made along trails, at entrances to fields, and near carcasses are often most productive. Many different sets are successful and can minimize the risk of nontarget capture.

Shooting

Harvest of foxes by sport hunters and fur trappers is another method of reducing fox populations in areas where damage is occurring. Depredations are usually most severe, however, during the spring, when furs are not saleable and it is hard to interest private trappers at that time.

Den Hunting

Fox depredations often increase during the spring whelping season. Damage may be reduced or even eliminated by locating and removing the young foxes from the den. Fox pups may be removed by trapping. In some situations it may be desirable to remove the pups without killing them.

LEGAL STATUS

Foxes in the United States are listed as furbearers or given some status as game animals by most state governments. Refer to the annual furbearer proclamation published by the Utah Division of Wildlife Resources concerning the trapping or killing of foxes.

RACCOONS

DAMAGE

Raccoons are a problem in and around homes and buildings in cities, towns, and farms. They occasionally eat pet foods and sweet corn in the backyards and fields, open garbage cans, crawl into chimneys, remove shingles from homes, and kill domestic chickens and ducks.

CONTROL METHODS

Prevention and Exclusion

Problems with raccoons are best solved through prevention and exclusion. Pet foods should not be left outdoors at night. Lids should be secured to garbage cans. Screens should be placed over chimneys to prevent entry. Tree limbs that extend over buildings should be removed or a cone shaped funnel should be placed around trees to prevent raccoons from crawling up trees and onto roofs where they may remove shingles.

Entrances into buildings should be repaired. If exclusion is not practical for solving raccoon problems, they can be captured in live traps baited with fish, fish flavored cat food, or commercial raccoon lures.

Trapping

Steel leg hold traps and Conibear traps may be appropriate if the locations exclude nontarget animals from accidentally being caught. No poisons or repellents are registered for raccoons in Utah.

LEGAL STATUS

Raccoons are not protected under state law in Utah, so no hunting or trapping license is required to take this animal. Utah law prohibits possessing a live raccoon without a permit.

DEER

BIOLOGY AND BEHAVIOR

Deer are probably the most widely distributed large mammals in North America. The mule deer is a western species and the primary species found in Utah. Adult mule deer may weigh 150 to 400 pounds. At birth, fawns are rust colored with white spots. Their spotted coats are shed in three to 4 months and are replaced by a grayish brown fall and winter coat. The summer coat of adult animals is reddish-brown. Under parts of the tail, belly, chin, and throat are white during all seasons.

Antlers grow on males from April to August. Mule deer antlers are forked, while the tines of a whitetail deer's antlers rise from a central beam. Mule deer antlers are shed in midwinter.

Browse that includes leaves, stems, and buds of woody plants is generally available all year and is a staple food for deer. Forbs are eaten in spring and summer. Fruits and nuts, especially acorns, are seasonally very important. Agricultural crops such as corn, soybeans, small grains, alfalfa, vegetables, and fruit trees are readily eaten when available.



Breeding occurs from October to January, depending on latitude. Peak activity is in November. The peak of fawn drop is in May or June. The majority of reproducing doe deer give birth to a single fawn; however, twin fawns are common. Reproduction potential is very sensitive to nutrition.

Deer are most active in early morning and evening. They have a home range of several hundred acres. Life expectancy is dependent on hunting pressure and regulations. Records show whitetails living 20 years, although 10 to 12 years is noteworthy in the wild.

DAMAGE

Deer damage a wide variety of row crops, forage crops, vegetables, fruit trees, nursery stock, and ornamentals, as well as stacked hay. In addition to the immediate loss of the crop being damaged, there is often residual damage in the form of future yield reduction of fruit trees or forage crops such as alfalfa.

Deer browsing may permanently disfigure ornamental trees or nursery stock. Under high densities, deer may severely impact native plant communities and impair regeneration of some forest tree species. Besides vegetative damage, collisions involving deer and vehicles pose a serious risk to motorists. Deer have been implicated in the distribution and transmission of Lyme disease.

Mule deer lack upper incisors and often leave a jagged or torn surface on twigs or stems that they browse. Rabbits and rodents leave a clean-cut surface. The height of

damage from the ground, up to six feet, often rules out any mammal other than deer. Deer often are seen in the act of causing damage and their track is very distinctive.

CONTROL METHODS

Exclusion

Temporary electric fences are simple, inexpensive fences useful in protecting garden and field crops during snow free periods. Permanent high tensile electric fences provide year round protection from deer and are best suited to high value specialty or orchard crops. The electric shocking power and unique fence designs present both psychological and physical barriers to deer. Permanent woven wire fences provide the ultimate deer barrier. They require little maintenance but are expensive to build.

Cultural Methods

Choosing landscape and garden plants that are less preferred by deer can minimize damage to ornamental plants. Harvest crops as early as possible to reduce the period of vulnerability by deer. Plant susceptible crops as far from wooded cover as possible to reduce the potential for severe damage.

Frightening Devices

Gas exploders, pyrotechnics, gunfire, or tethered dogs provide temporary relief. To maximize the effectiveness of exploders, move them every few days and stagger the firing sequence. Deer quickly become accustomed to the regular patterns. Raising exploders off the ground can increase the noise level. The success of frightening devices ranges from good to poor.

Repellents

Contact repellents, which are applied directly to the plants, repel by taste. They are most effective when applied to trees and shrubs during the dormant period. New growth that appears after treatment is unprotected. Contact repellents may reduce the palatability of forage crops and should not be used on plant parts destined for human consumption.

The effectiveness of repellents will depend on several factors. Rainfall will dissipate some repellents, so reapplication may be necessary after a rain. Some repellents do not weather well. The hunger of deer and the availability of other more palatable food will have a great effect on success.

Herd Reduction

Overall reduction in a state's deer population might reduce deer damage, but public opinion generally does not favor this approach. Damage may result from a few problem deer or at locations close to a wintering area or other exceptional habitat.

Shooting

Effective use of the legal deer season is probably the best way to control deer populations. By permitting hunting, landowners provide public access to a public resource while at the same time reducing deer damage problems. Shooting permits issued by some states allow for removal of problem deer when they are causing damage during nonhunting seasons.

LEGAL STATUS

Deer are protected game animals and they can be killed during the hunting season with the appropriate license. Regulations vary on the necessary permits and on disposal of dead animals. The popularity of deer as game animals and the need to curb poaching has led to the development of severe penalties for illegal killing or possession.

ELK

BIOLOGY AND BEHAVIOR

The elk is a large powerful animal with an adult weight averaging more than 400 pounds. The pelage or hair coat is light to dark reddish-brown on the body, a darker brown on the neck and legs, and creamy on the large rump patch. Bulls grow large impressive antlers with six or more tines branching from two heavy central beams.

Elk graze on grasses and forbs and they browse on shrubs, tree seedlings, and saplings. Diet is variable, depending on the availability and nutritive content of forages. Elk dietary preferences often overlap those of domestic and other wild ungulates. Where both grasses and shrubs are available, elk may favor grasses.

When snow reaches sufficient depth to cover grasses and shrubs, elk are forced to rely on conifer seedlings, saplings, bark, and twigs of deciduous trees such as aspen. Wind fallen branches and attached arboreal lichens are an important energy source in winter.

Although elk once roamed freely into lower elevation grasslands, they are now found mainly close to heavily forested areas that are dotted with natural or clear-cut openings. Typically, elk use the openings to forage for food. Elk seek the shelter of dense stands of conifer and deciduous trees for protection from temperature extremes, predation, and harassment by humans.

Elk usually spend their summers at higher elevations. In the fall they migrate along traditional corridors ranging in distances from 2 to 80 miles. The migration allows elk to reach lower elevations and escape weather extremes and snow depths that prohibit foraging in winter. Some herds spending the entire year in one area and do not migrate,

Weather and human activities influence elk activity. Where no hunting is allowed, elk readily get used to humans and may be seen foraging during daylight hours. Otherwise, elk tend to forage mainly in early morning, in late afternoon, and during the night.

Elk forage more on warmer south-facing slopes during daylight hours in colder months, retiring to the thick protective cover of conifer/deciduous forests in early afternoon. In the summer elk forage early in the day when temperatures are cooler and seek refuge from midday heat and insects in cooler riparian areas or forested, windswept ridge tops.

The breeding season, the rut, begins in late summer when dominant bulls herd groups of cows together for

Breeding. Cow elk may breed as yearlings, but many breed first as 2-year olds. A single calf is born about 250 days following conception.

DAMAGE

Elk use a variety of habitats and habitat components such as slope to optimize feeding opportunities, thermal regulation, and protection from predation. This flexibility is closely associated with the impact elk have on domestic hay, grain crops, and pastures...

Elk also damage forest resources by feeding on seedlings and saplings of coniferous and deciduous trees. Elk damage problems are increasing on property developed in traditional elk wintering ranges. This problem can be avoided by zoning regulations that prohibit development in such areas.

The elk is a highly desired game animal and management efforts have been directed at increasing the size of elk herds. As elk numbers have gradually increased, the incidence and intensity of damage to agriculture and forestry have also increased.

Plants browsed by elk have a characteristic appearance. Vegetation is grasped between the lower incisors and the upper palate and ripped or torn resulting in splintered and fragmented plant parts. Elk damage to conifer seedlings may appear as a thorough stripping of bark from the upper half of the growing tip. The appearance of damage to browsed plants is similar for elk, deer, and cattle, but their tracks and droppings are easily distinguished.

Elk tend to roam over greater expanses of habitat than deer, so the occurrence of damage by elk is more widespread and sporadic than damage by deer. Also, because elk move as groups instead of singly, the destruction to crops and pastures includes trampling like that of domestic livestock.

CONTROL METHODS

Exclusion

Fencing has provided relief from elk damage where plants cannot be protected individually, such as in hay and grain fields, large orchards, and pastures. Six-foot high woven wire fences topped with two strands of smooth or barbed wire will prevent access, but the cost is high.

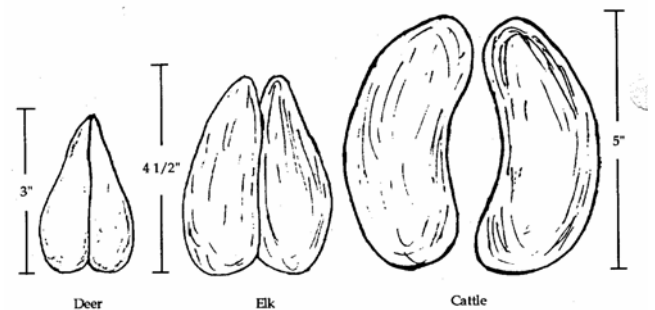
Recently, high voltage electric fences have proven to be a relatively inexpensive and effective alternative to woven wire fences. Considerable expertise is required to build these fences, but when built properly, they can provide nearly as much protection from damage as mesh fences.

Haystacks can be protected from elk for one or two seasons by wrapping plastic barriers around them. Ten-foot wide sheets of black plastic or netting made of expanded polyethylene are commonly used. Individual trees can be protected with 6-foot cylinders of welded wire.

Cultural Methods

Under limited circumstances, elk may be deterred from damaging crops by planting other forages that elk prefer. Food plots and salt blocks have been used on public lands adjacent to agricultural fields and pastures to reduce damage by resident and migratory elk. Effectiveness of this approach is still undergoing evaluation.

Planting taller seedlings can reduce elk damage. Seedlings average 18 inches in height. Seedlings 36 inches or taller will provide more browse than elk can crop. Seedlings this size can grow out of the reach of elk faster.



Where elk and livestock compete for the same forage the cattle should be placed on the pasture in late spring and removed in late summer. The forage will recover in early fall and provide forage for elk in winter. The elk, in turn, will

crop and stimulate the forage, providing good forage for cattle returning to the pasture in spring.

Frightening Devices

Propane exploders can prevent elk from using sites for several weeks, after which the elk lose interest and go elsewhere. Exploders are most effective when their locations are changed every few days so that elk do not get accustomed to the sound pattern.

Repellents

Repellents may reduce elk damage in orchards, vineyards, and conifer plantations. Where frequent rains occur, some repellents must be applied more than once. Damage can be prevented without treating the entire area by applying odor repellents to plants within a 25-foot wide strip around field edges where most of the damage occurs.

Population Reduction

Permits are issued for antlerless elk to reduce local elk populations. These reductions are for local herd reduction and problem animal elimination. Special elk damage hunts are established to reduce the size of herds on public lands and, in some cases, on private property. The second kind of reduction is for individual landowners that experience unacceptable losses of crops to one or a few elk. Permits are issued to the individual landowner to eliminate these problem animals.

Another form of population reduction is the translocation of problem animals. Capturing and translocating elk was a common procedure when there were areas understocked with elk. These programs are being phased out, because states with sufficient elk to cause damage problems no longer have areas of too few elk.

Another method of population reduction is the use of elk reproductive inhibitors. Unfortunately there is no effective delivery system available to implant or inject the inhibitors into the bodies of free ranging elk.

LEGAL STATUS

Elk are protected game animals and they can be killed during the hunting season with the appropriate license. Regulations vary on the necessary permits and on disposal of dead animals. The popularity of elk as game animals and the need to curb poaching has led to the development of severe penalties for illegal killing or possession.

III MANAGEMENT OF BIRD PESTS

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BIRD PESTS

Several species of birds cause problems in Utah. The problems include roosting and defecation, consumption of grain, contamination of feed, and transfer of diseases. Problem species include feral pigeons, starlings, house sparrows, woodpeckers, and magpies. In addition to birds covered in this guide other birds such as ducks, geese, seagulls, cormorants, mergansers, herons, cranes, crows, ravens, blackbirds, eagles, owls, vultures, and swallows occasionally cause problems in Utah.

PIGEONS

BIOLOGY AND BEHAVIOR

Pigeons are really rock doves that were introduced from Europe by early settlers. They are now widespread and common across North America. Building ledges, rafters, and eaves are typical nesting sites for pigeons. The pair builds a rather messy nest in which the female lays one

or two eggs. The incubation period is 17 to 19 days. The young are fed predigested food until they are weaned and leave the nest at 35 to 37 days of age.

Breeding occurs during all seasons and several broods are raised each year. Pigeons live an average of five to seven years with some living more than 15 years. An adult pigeon will eat about one pound of food a week including seeds and other grains augmented with fruit, green feed, insects, and sufficient grit for digestion.

DAMAGE

Pigeons are abundant in cities and around rural areas of Utah. They conflict with humans in several ways. Their droppings deface buildings, kill vegetation, and are aesthetically displeasing when deposited on benches, sidewalks, and cars. Pigeons eat and contaminate grain destined for human consumption.

Pigeons carry pigeon ornithosis (psitacosis), encephalitis, Newcastle disease, toxoplasmosis, salmonella food poisoning, and other diseases. Histoplasmosis, a fungal disease that can infect people, can be contracted from accumulations of dusty pigeon manure. Pest controllers should wear a respirator when working around pigeon manure. Pigeon ectoparasites such as mites, lice, and ticks may readily bite people.

CONTROL METHODS

Exclusion

Pigeons can be excluded from buildings by placing hardware cloth or plastic netting over eaves, vents, windows, doors, and other openings. The angle of roosting ledges can be altered to 45 degrees or more using sheet metal or wood. Various sticky substances can be placed on ledges to discourage pigeons.

Frightening Devices

Noisemaking devices and ultrasonic sound, revolving lights, and fake owls or snakes have little permanent effect for frightening pigeons from roosting areas.

Nest Removal

Removing nests and destroying young also helps to depress pigeon populations, but the cost of accessing nests may make the cost to benefit ratio unacceptable.

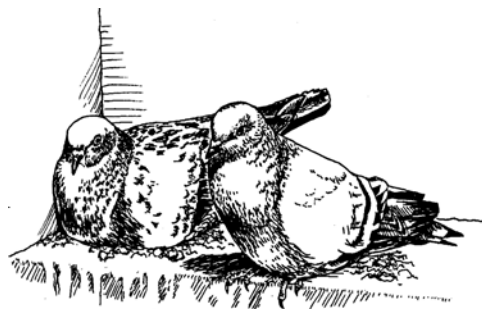
Shooting

Where local ordinances permit a flock of pigeons may be shot. Shotguns work best, but .22 caliber bird shot or compressed air guns can be effective at close range.

Trapping

A colony of pigeons tends to use regular feeding and roosting areas and can sometimes be controlled by intensive trapping at these locations. Large traps have been reported to be more effective than smaller ones. However, smaller traps are less expensive to build and easier to transport. Suggested baits include whole or coarse cracked corn, wheat, or milo. Water should be available in the trap at all times.

Traps with funnel entrances are the most effective. Heavy prebaiting for a period of time in and around traps with the doors left open may be necessary to get pigeons to visit the trap readily. Live decoys in the trap will help attract other pigeons. White or light colored birds make better lures than drab, blue gray ones. If possible, leave the same individuals in the trap.



Baits

Avitrol, a chemical frightening agent, is available as a mixed grain, corn chops, or whole corn bait for pigeon control. It is a restricted use pesticide. Birds that eat sufficient amounts of the treated bait will die, but the distress symptoms display frighten other members of the flock away. In urban areas, this chemical should be used cautiously, because high mortality can cause adverse public reaction. No other toxic baits are registered for pigeon control in Utah.

LEGAL STATUS

Feral pigeons are not protected by federal law, and most states do not afford them protection. State and local laws should be consulted, however, before any control measures are taken.

STARLINGS

BIOLOGY AND BEHAVIOR

European starlings were imported into New York in 1890 and have spread across the North American continent. Starling nests are built in tree cavities, openings in buildings, or deserted woodpecker holes of suitable size. Two to eight eggs are laid and the incubation period is 11 to 13 days. Both sexes help in this activity.

DAMAGE

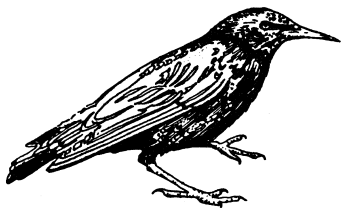
As fledglings leave the nest they gather in small family groups of up to 10 birds, including 1 or 2 adults. These small groups merge together into large flocks. Merging continues until all of the birds in a local area are in one large flock. These flocks are responsible for depredations to soft fruits and other summer crops.

CONTROL METHODS

Frightening Devices

Devices such as shell crackers, spraying with water, propane exploders, broadcast distress calls, and electronically produced sounds can frighten starlings

from roosts. Begin the use of these devices as soon as birds make an appearance. It generally takes a persistent effort to move the birds from a favorite roost. Use a combination of frightening devices as soon as the first birds arrive.



Cultural Methods

Starlings can be discouraged from using livestock facilities by removing spilled grain and standing water, using bird proof feeders and storage facilities, feeding livestock in open sheds, feeding livestock in late afternoon, and lowering water levels in water tanks.

Exclusion

Starlings can be excluded from rafters with plastic or wire mesh bird netting. They can be excluded from ledges with wires, various sticky substances such as Roost-No-More and Bird Tanglefoot, and by altering the angle of the ledge to 45 degrees or more with sheet metal or wood.

Shooting

Shooting is costly and rather futile because of the large numbers of starlings. However, shooting can be used in conjunction with frightening devices.

Trapping

A trailer may be converted into a large mobile trap by building entrances on top and plugging all escape holes. In some instances slot entrances have proven more effective while at other times wire entrances were more successful.

The trap location is important. Observations should be made to determine starling flight paths, resting or perching areas, and feeding areas before the traps are placed in operation. These traps have been most effective when placed in the open near, but not necessarily under, perching or feeding areas.

Baits that have been used successfully include soft fruits, raisins, and poultry pellets. Bait placed on the ground inside the trap in large amounts with a little on the top near the entrance is most effective. Bait materials that the birds feed on in the area should be used for best results.

Baits

Avitrol is a restricted use pesticide and a chemical frightening agent that can be spread in empty pens and alleyways of feedlots. Starlings that ingest sufficient bait

will die, but they first display distress symptoms that frighten other members of the flock from the area.

Starlicide is a restricted use pesticide that is registered for use on starlings in feedlots. The treated pellets should be mixed 1 to 10 with untreated pellets and scattered in empty pens and alleyways. This toxicant is available in pellet form, so prebaiting will be necessary if starlings are feeding on grain. Starlicide is a slow acting poison that takes up to 48 hours to kill the birds; many birds die at roost sites.

LEGAL STATUS

European starlings are not protected by federal law and are not protected birds in Utah. Check with the Utah Division of Wildlife Resources before poisoning birds.

HOUSE SPARROWS (ENGLISH SPARROWS)

BIOLOGY AND BEHAVIOR

House sparrows, also known as English sparrows, are established throughout North America. Nest building begins as early as April, with both sexes taking part in the activity. Nests may be located almost anywhere. Three to seven eggs are laid, commonly five, and two or three broods are raised each year. Soon after the young leave the nest, they gather in small flocks. As the summer advances, adults join the juveniles until the flock may number several hundred.

DAMAGE

Damage from house sparrows includes loss of grain in fields, animal feed stations, storage sheds, and feedlots, and depredation on sprouting vegetables and flower crops, seeds of newly seeded lawns, fruit tree and ornamental buds, and pecking of ripening fruit.

The house sparrow harbors the chicken louse and the bird louse. House sparrows are capable of transmitting fowl cholera, turkey blackhead, Newcastle disease, avian tuberculosis, Eastern equine encephalitis, pullorum, canary pox, anthrax, and numerous helminths, fungal and protozoan parasites. The noise and filth associated with their nests are nuisances in urban areas.

CONTROL METHODS

Exclusion

Sparrows can be excluded from buildings with 1/2 to 1 inch hardware cloth or plastic netting. The angle of roosting ledges should be altered to 45 degrees or more with sheet metal or wood. Wires such as Ninlite or Cat Claw can be placed on ledges and ridges of buildings to prevent roosting. Various sticky substances such as Roost-No-More and Bird Tanglefoot can be placed on ledges to discourage sparrows.

Trapping

A wide variety of traps have been used for local control of house sparrows. Traps that are designed to catch only a few birds at a time include the double funnel trap, the nest trap, and the commercially available elevator trap.

Portable trailer and tent type traps are used to catch large numbers of birds. Chick scratch, fine cracked corn, milo, wheat, bread crumbs, or their combinations make good baiting material and food sources for decoys and captured birds.

Baits

Avitrol, a chemical frightening agent, is available for sparrow control. It is a restricted use pesticide. Birds that eat enough of the treated bait will die, but they first display distress symptoms that frighten other members of the flock away. In urban areas, this pesticide should be used cautiously, because high mortality can cause adverse public reactions.

Nest Removal

Removing nests and destroying young also help depress sparrow populations, but inaccessibility of nests makes the cost to benefit ratio unattractive.

Shooting

Where local ordinances permit, sparrows can be shot with shotguns, .22 caliber bird shot or compressed air guns; however, shooting is costly and time consuming.

LEGAL STATUS

The house sparrow is not protected by federal law and it is not a protected bird in Utah. Check with the Utah Division of Wildlife Resources before poisoning birds.

WOODPECKERS

BIOLOGY AND BEHAVIOR

Woodpeckers are 7 to 15 inches long and have short legs, sharp clawed toes, and a stiff tail. Most woodpeckers feed on wood boring insects, vegetable matter, berries, or tree sap.

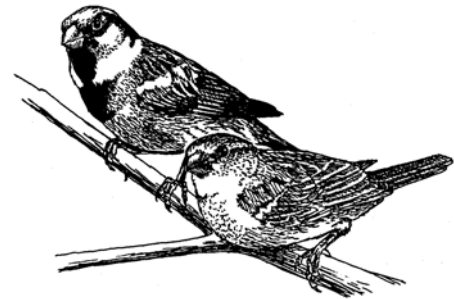
The northern flicker, which is responsible for most woodpecker damage to Utah homes, can be identified in flight by a yellow or reddish tint under the wing and tail feathers. The hairy, downy, three-toed, and Lewis's woodpecker and the red-naped and Williamson's sapsucker occasionally cause problems in Utah.

DAMAGE

Woodpeckers can cause an annoyance by hammering or drumming on houses and can cause property damage by drilling holes in wood siding and eaves. Woodpeckers

hammer to attract mates, establish and/or defend a territory, excavate nesting or roosting sites, and search for insects.

Wooden shingles, cedar or redwood siding, metal or plastic guttering, television antennas, and light posts are selected as drumming sites because these materials produce loud sounds. The majority of damage occurs to cedar, rough pine, and redwood siding, although other siding materials are occasionally damaged. Drumming is most common in the spring during early morning and late afternoon. Drumming usually ends by early July.



CONTROL METHODS

Woodpecker damage can be prevented or eliminated with several techniques, including loud noises, exclusion, alternative building materials, and repellents. Immediate action should be taken to reduce damage and because woodpeckers are not easily driven from their pecking sites once they become established.



Prompt repair of large holes may encourage the woodpecker to leave or discourage other woodpeckers because these holes may serve as visual attractants. The holes can be covered with aluminum flashing or metal sheathing and painted to match the siding. If damage is

occurring near areas that provide perch sites elimination of such sites can solve the problem.

Loud Noises

Some woodpeckers can be frightened away with persistent loud noises such as banging pots and pans together, firing toy cap guns, or yelling. Deadening the sound producing area by filling the hollow space behind the wood can discourage some woodpeckers.

Exclusion

Woodpeckers can be excluded from damage sites under the eaves by attaching hardware cloth or plastic netting to the eaves to prevent access by birds.

Alternative Building Materials

Woodpeckers occasionally damage houses to obtain insects in the wood. Woodpeckers hammer holes to obtain insects. Insecticides or wood preservatives can deter woodpeckers by reducing or eliminating the insects.

Repellents

Sticky bird repellents such as Tanglefoot or Roost-No-More applied to siding and other areas may discourage woodpeckers because they create a tacky footing. In areas where woodpeckers are a persistent problem, future homeowners should consider building homes from materials that woodpeckers are not prone to damage such as brick, metal, and products other than wood.

Preliminary research indicates that predator bird silhouette mobiles and 7.5 inch diameter shaving mirrors that enlarge the image are successful frightening devices. Black plastic cut from garbage bags, aluminum foil strips 2 to 3 feet long, pinwheels with reflective vanes, or aluminum pie tins blowing in the wind will frighten woodpeckers.

LEGAL STATUS

When nonlethal control methods fail to deter woodpeckers, lethal control may be required. Woodpeckers are classified as migratory nongame birds and are protected by the Federal Migratory Bird Treaty Act. A federal permit is required for any lethal control.

MAGPIES

BIOLOGY AND BEHAVIOR

Black-billed magpies are members of a bird family that also includes ravens, crows, and jays. They are easily distinguished from other birds by their size and striking black and white color pattern. They have unusually long tails, half their body length, and short rounded wings. The feathers of the tail and wings are iridescent, reflecting a bronzy green to purple. They have white bellies and shoulder patches and their wings flash white in flight.

Two distinct species are found in North America, and the black-billed species is found in Utah. Black-billed magpies average 19 inches in length and 1/2 pound in weight. They have black beaks and no eye patches. They are typically found close to water in relatively open areas with scattered trees and thickets.

Magpies are omnivorous and very opportunistic. They have a preference for animal matter, primarily insects, but readily take anything that is available. Congregations of magpies can commonly be seen along roadsides feeding on animals killed by cars or in ripening fruit and nut orchards. They also pick insects from the backs of large animals. Their diet changes during the year reflecting the availability of foods during the different seasons.

Eighty percent of the black-billed magpie's diet consists of insects, carrion, small mammals, small wild birds, hatchlings, and eggs. The balance of its diet consists of fruits and grains. Magpies often store or cache food items in shallow pits that they dig in the ground.

Magpies are intelligent birds that learn quickly and seem to sense danger. They mimic calls of other birds and can learn to imitate some human words. They readily adapt to the presence of humans and take advantage of the food sources provided.

Nest building typically begins in early March for black billed magpies. They build large nests, sometimes 48 inches high by 40 inches wide, in bushes or in trees usually within 25 feet of the ground. Magpie nests are usually found in small colonies. Other species of birds and mammals often use magpie nests after they have been abandoned.

Black-billed magpies lay six to nine eggs. Incubation normally starts in April. The incubation period is 16 to 18 days and young are able to fly 3 to 4 weeks after hatching. Young forage with the adults and then join other groups in summer to form loose flocks. Winter congregations may include more than 50 individuals.

DAMAGE

Magpies can cause substantial damage locally to crops such as almonds, cherries, corn, walnuts, melons, grapes, peaches, wheat, figs, and milo. Their damage is probably greatest in areas where insects and other foods are relatively unavailable.

Magpies are often found near livestock where they feed on the insects attracted to dung and carrion. They also forage for ticks and insects on the backs of domestic animals. Perhaps the most notorious magpie behavior is the picking of open wounds and scabs on the backs of livestock. Magpies, like ravens, may peck the eyes out of newborn or sick livestock.

Magpies eat eggs and hatchlings from wild bird and poultry nests. They can be very destructive to poultry during the nesting season when magpie parents are gathering food for their young. Magpie can be a nuisance because of their excessive noise and the odor associated with their droppings.

CONTROL METHODS

Exclusion

Exclusion is generally not practical to protect crops from magpie depredation unless crops are of high value or the area to protect is relatively small. Nylon or plastic mesh netting can be used to cover crops. The netting is expensive and labor intensive making it expensive to use.

Exclusion is an ideal method to keep magpies from livestock when it is economical to do so. Poultry nests and young kept in fenced coops and feeding areas are safe from magpies. Lambing pens can reduce the incidence of eye pecking. Livestock with open wounds or diseases can be kept in areas that exclude magpies until they are healthy.

Habitat Modification

Predation on poultry often increases during magpie breeding season. Raids of increasing intensity can often be tied to a few offending breeding pairs with young. Removal of their nests can effectively reduce predation.

Clear low brush and trees to reduce nesting and roosting habitat in areas where black-billed magpies are regularly concentrated and cause regular damage. This method reduces habitat for all wildlife and should be carefully considered before being undertaken.

Frightening Devices

Frightening devices are effective for reducing magpie depredations to crops and livestock. A combination of human presence, scarecrows, pyrotechnics, and propane cannons provide a good frightening or hazing program and can reduce depredations significantly. The success of these devices varies greatly with location, availability of

alternate food supplies such as insects, and how the techniques are used.

In a hazing program the periodic presence of a person is important because it reinforces the techniques. The mere presence of a person will keep magpies at a distance, especially where magpies have been hunted.

Trapping

Trapping is effective in reducing local magpie populations where they are concentrated in high numbers because of food availability or winter conditions. Several trap designs have been successful in capturing magpies. Traps made of weathered materials are most successful, but it still takes time for magpies to get used to traps. Traps are most effective in areas frequented by magpies or along their flight paths. Consult federal, state, and local laws before trapping.

Shooting

Shooting can be an effective means to eliminate a few offending magpies or to reduce a local population. Shotguns are recommended for shooting. Magpies can be stalked or shot from blinds under flight paths. They also can be lured with predator calls. Magpies, though, quickly become wary and learn to avoid hunters. Shooting in conjunction with a hazing program provides greater control of damage than does shooting alone. Consult federal, state, and local laws before shooting.

LEGAL STATUS

Magpies are protected as migratory nongame birds under the Federal Migratory Bird Treaty Act. Special control measures apply when magpies are committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife or when

concentrated in such numbers as to constitute a health hazard or other nuisance. Contact the Utah Division of Wildlife Resources concerning problem magpies.

IV. MANAGEMENT OF OTHER PESTS

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OTHER PESTS

Other pests in Utah include lizards and amphibians. These animals are not significant pests in Utah and are not discussed in this study guide. Fish pests and rodent pests are discussed in the manuals specific to each license category. Fish are covered in the Study Guide for Aquatic (Surface Water) Pest Control. Information specific to the control of domestic or commensal rodents in and around structures is covered in the Study Guide for Structural Pest Control.

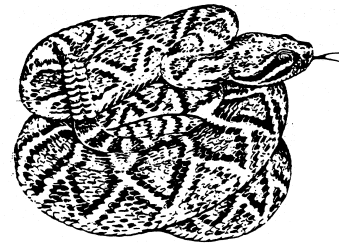
SNAKES

BIOLOGY AND BEHAVIOR

Snakes are reptiles. They have scales, are exothermic and must rely on external sources to control their body temperature, and like most reptiles they lay eggs. Snakes often shed their skin more than once each year to accommodate their growing bodies. Snakes must avoid extremes in temperatures and they prefer to hunt during mild conditions. Their forked tongues and heat sensitive facial pits are used to determine what exists in their environment and to acquire prey. Most snakes prey predominantly on rodents, although some will also eat bird eggs, nestlings, and insects. Snakes such as garter and gopher snakes and racers may occasionally be pests, but they are nonvenomous.

Of the 32 species of snakes inhabiting Utah, the western rattlesnakes, the southwestern speckled rattlesnakes, the Mojave rattlesnakes, and the Mojave Desert sidewinders are the only venomous species. The western rattlesnake appears in most habitats throughout the state. The other three venomous species are in Washington County in southwestern Utah. There are four subspecies of the

western rattlesnake, with the great basin rattlesnake being the most common. Rattlesnakes give birth in the autumn to hatches of 5 to 12 young, approximately 8 inches in length.



There are five ways to distinguish venomous from nonvenomous snakes.

1. There are rattles at the end of the tail, but the rattles may have broken off or the rattlesnake could be too young to have rattles yet.
2. Front fangs in addition to their rows of teeth.
3. Facial pits between the nostrils and eyes.
4. Broad, triangular head with the neck about half the width of the jaw.
5. Vertical and elliptical pupils may look like thin lines. Nonvenomous snakes have round pupils.

DAMAGE

Snakes may take up residence under and possibly inside buildings. This behavior may become more noticeable in the fall when snakes begin seeking areas to hibernate for the winter. Nonvenomous snakes do not pose major problems for humans.

A dead rattlesnake cannot strike, but the head, even decapitated, is still capable of biting and injecting poison. The snake's heat sensory pits are active until rigor mortis sets in and they can trigger a biting response if a warm object, such as a hand, is placed near the snake's mouth.

If bitten by a rattlesnake, remain as calm as possible because panic may actually trigger adverse physical reactions. Since there is a single antivenin available for use against all rattlesnakes in the United States there is no need to deliver the snake for identification prior to medical treatment.

If it is a venomous snakebite, there may be one or two visible fang marks in addition to teeth marks. Evidence of a bite does not necessarily mean venom has been injected. The common and fairly quick reactions to envenomation are swelling and pain in the bite area, followed by a black and blue discoloration of the tissue and possibly nausea.

If bitten get to a hospital as soon as possible. Remove items that may cause restrictions such as rings, shoes, and watches before swelling begins. Physicians do not recommend the use of a tourniquet, bite incisions, or suction. Antivenin may cause severe allergic reactions and it should be administered in a hospital where the patient can be closely monitored.

CONTROL METHODS

Prevention

Eliminate locations such as brush piles, growth adjacent to foundations, and high grass that provide shelter where snakes hide. Eliminating food sources such as insects and rodents will force snakes to seek food elsewhere. In areas with rattlesnake infestations consider building a snake proof fence around the yard or children's play areas. All vegetation should be kept away from fences to discourage snake access. Prevent snakes from entering structures and crawl spaces by sealing openings with mortar or hardware cloth. Common entry sights include opening around doors, windows, and pipes.

Be Prepared

If walking or hiking in areas inhabited by rattlesnakes, wear long, loose pants, and calf high boots or snake guard materials. Rattlesnakes are generally nonaggressive toward humans unless they are stepped on, startled, or cornered. Rattlesnakes do not always rattle their tails before striking so do not rely solely on the sense of hearing. If confronted by a rattlesnake, try to remain calm and move away carefully.

LEGAL STATUS

According to the Utah Division of Wildlife Resources, a person may not indiscriminately kill any reptile and they may not disturb the den of any reptile or kill, capture, or harass any reptile within 100 yards of a den without first obtaining a certificate of registration from the division. Rattlesnakes may be killed without a certificate of registration only for reasons of safety.

DOMESTIC OR COMMENSAL RODENTS

BIOLOGY AND BEHAVIOR

The three main domestic or commensal rodents found in Utah are the Norway rat, the house mouse, and the deer mouse. Domestic rodents are the chief vertebrate pests of humans because of their great reproductive capacity and their ability to adapt to new environments.

NORWAY RAT

The Norway rat is the common domestic rat in Utah. It has coarse hair, close set ears, and its muzzle is blunt. The tail is dark on the top and light on the underneath side. The tail is shorter than the combined length of the head and body.

The fur is gray brown on the back and gray white on the belly. The adults weigh between 12 and 20 ounces and the combined length of the head and body is 7.5 to ten inches long. The tail length is between six and 8.5 inches. The feces are capsule shaped and about 0.75 inch long.

Norway rats can be found in warehouses, farm buildings, houses, sewers, rubbish, dumps, woodpiles, and building foundations. They are good climbers and they can jump 24 inches vertically. The Norway rat has relatively poor vision but keen senses of smell, touch, taste, and hearing. Long whiskers on the snout serve the sense of touch. Their home range is often 100 to 200 feet.

Norway rats and other domestic rodents are mainly nocturnal, but they may go about in undisturbed places during the day. They feed on virtually anything edible. Norway rats are unable to vomit. They must drink water to survive.

HOUSE MOUSE

The most common household rodent is the house mouse. This mouse has large ears, a pointed muzzle, and a slender body. The tail is unicolored, has little hair, and is about as long as the head and body combined.

Adults weight 0.5 to 0.75 ounce and the combined length of the head and body are 2.5 to 3.5 inches long. The tail measures between three and four inches long. The feces are rod shaped, 0.125 to 0.25 inch long.

Although house mice are commonly found living in structures built by humans, they are also well adapted to living outdoors. They are common inhabitants of grassy fields and cultivated grain crops. Wild populations often move into buildings when weather becomes severe. The house mouse has poor vision and is colorblind. Mice have keen senses of smell, taste, hearing, and touch. They use

their sense of smell to locate food items and recognize other individual mice.

Mice use their long, sensitive whiskers on the nose and above the eyes as tactile sensors. The whiskers and guard hairs enable the mice to travel easily in the dark. House mice feed on a wide range of foods, although cereals seem preferred over other items. Most mice favor grains. Supplemental food items include foods high in fat and protein, such as lard, butter, nuts, and dried meats.

The two main feeding periods of mice are at dusk and dawn. Because of their small size, mice must feed several times during a 24-hour period. This means that they are active day and night. Their range is normally 10 to 30 feet from the nest.

DEER MOUSE

The native deer or white-footed mouse occasionally invades buildings adjacent to fields or woodlands. Deer mice are about the same size or slightly larger than house mice. Deer mice can be differentiated from house mice by a distinct, bicolored tail with the upper portion brown gray and the lower portion white. Deer mice have small ears and eyes and a relatively short tail.

The deer mouse is the most common host of the Hantavirus, but other small animals may carry the disease. Hantavirus is a viral illness transmitted from saliva, stool, or urine of infected animals. Once these waste products dry, the virus can become airborne. Infection usually results when the virus is inhaled. The illness is described as a severe respiratory illness that results in death for about 50 percent of its victims. Avoid activities involving exposure to mouse droppings.

DAMAGE

Domestic rodents contaminate food by defecation, destroy structures by gnawing, transmit diseases, and harbors parasites hazardous to humans and animals. Some of the diseases that rodents convey to humans are plague, murine typhus, infectious jaundice, poliomyelitis, food poisoning, ratbite fever, and rabies.

Physical Capabilities of Rodents

The Norway rat can:

Gain entrance through any opening that is larger than 0.5 inch square.

Crawl horizontally on any pipe or conduit.

Climb both horizontal and vertical wires.

Climb the inside of vertical pipes that are 1.5 to 4 inches in diameter.

Climb the outside of vertical pipes and conduits up to three inches in diameter.

Climb vines, shrubs and trees or travel along telephone or power lines.

Climb brick or other rough exterior walls that offer footholds.

Jump vertically as much as 36 inches.

Jump horizontally as much as 48 inches.

Jump a gap of 8 feet and greater from an elevation of 15 feet.

Drop 50 feet without being seriously injured.

Burrow vertically in earth to a depth of four feet.

Swim as far as 0.5 mile in open water, travel submerged through water, and travel in sewers.

Gnaw through a wide variety of materials, including lead, adobe brick, cinder block, and aluminum sheeting.

The house mouse can:

Gain entrance through openings slightly larger than 0.25 inch in diameter.

Jump 12 inches horizontally.

Jump against a vertical surface and use it as a springboard to gain additional height.

Jump from a height of eight feet without injury.

Run up almost any rough vertical surface, including brick walls, wood, weathered sheet metal, wire mesh, and cables.

Run horizontally along insulated electrical wires and small ropes.

Travel upside down along 0.25 inch hardware mesh.

Swim if it needs to, but do not dive below the surface, as do rats.

CONTROL METHODS

Rodent control may involve the use of several control measures, including cleanup or sanitation, rodent proofing, and the use of toxicants and traps. Sanitation is important for rodent control. The elimination of shelter, food, and water is important.

Keep grass, weeds, and other vegetation away from buildings. Piles of lumber, rocks, rubbish, and old equipment should be located away from buildings. Information specific to the control of domestic or commensal rodents in and around structures is covered in the Study Guide for Structural Pest Control.

Rodenticides

Both single dose and multiple dose anticoagulant rodenticides are available for rat and mouse control.

Finished baits are available in a wide assortment and rodenticide concentrates can be purchased to prepare poison baits.

Prebaiting

Mice and rats are cautious feeders and may reject new foods or eat only small amounts for the first several days. Conditioning rats to feed on a nontoxic version by prebaiting can increase acceptance of toxic bait. If acceptance of prebait is poor, the bait should be changed. Once a prebait is accepted the toxic bait should be used.

Single Dose Rodenticides

Single dose rodenticides will give a quick knockdown of rat and mouse populations, and they may be preferred where rats and mice are abundant or where it is hard to get rats and mice to accept bait for several days in succession because of competing food items.

When rats or mice consume a sublethal amount of an acute toxicant, "bait shyness" or "poison shyness" may result. Because of bait rejection problems, single dose poisons should not be used more than twice a year at a given location, and preferably only once.

Multiple Dose Rodenticides

Multiple dose anticoagulant rodenticides are generally considered much safer than single dose rodenticides. When anticoagulant baits are properly formulated bait shyness does not occur. Most anticoagulants rodenticides cause death to mice and rats after several days of feeding. When using anticoagulant rodenticides, fresh bait should be made available for at least two weeks or until all signs of feeding cease.

Bait Selection and Placement

Anticoagulant baits are available in several types. Grain baits in a meal or pellet form are packaged in small plastic, cellophane, or paper packets. These packets keep baits fresh and make it easy to place baits into burrows, walls, or other locations. Rats and mice will readily gnaw into these bags to get at the bait.

Anticoagulant baits that have been formulated into paraffin blocks are also available. These blocks are useful in sewers or where moisture may cause loose grain baits to spoil. Acceptance of the paraffin-block baits by rats and mice is usually less than acceptance of loose-grain baits.

Sodium salts of anticoagulants are available to be mixed with water. Since rats require water daily, they can be drawn to baited water stations. Although mice require little water to survive, water baits used where moisture is scarce can be an effective supplement to other control measures.

The use of bait stations or boxes protects rodenticides from weather and provides a safeguard to people, pets, and other animals. Bait stations should have at least two openings and be large enough to accommodate several rats or mice at one time. Bait boxes should be placed where rats or mice are active. All bait boxes should be clearly labeled "Rat Bait" or "Mouse Bait," as the case may be.

Pest control professional should keep a written record of the locations of all bait stations so that another person can inspect and replace baits as needed. Records should be kept of activity indicating whether baits have been disturbed, if dead rodents were found, and the observation of droppings or tracks.

Fumigants

Fumigants are often used to control rodents in their burrows in outdoor situations, sometimes in rail cars, and on ships. Fumigants are highly toxic to people and animals and they must not be used in any situation that might expose the occupants of a building to the vapors. Because of the hazards involved with fumigants, only persons licensed for fumigation pest control should use fumigants.

Rodenticide Safety Precautions

All rodenticides that present some degree of hazard to animals other than rodents. Persons who formulate rodent baits for their own use should use extreme care in handling the materials. Follow the label directions when handling rodenticide formulations. Wash thoroughly after preparing baits, using soap and water. Ready-to-use baits are safer to handle because they reduce risks involved in handling concentrated toxicants.

The carcasses of poisoned rats and mice should be collected using tongs or rubber gloves. The bodies should be disposed by incineration or burial. In instances where there are only a few, they can be placed in a plastic bag and dispose of with other refuse. Remove and destroy all uneaten bait at the end of the poisoning period.

Traps

Trapping can be an effective method of controlling rats and mice. Trapping is recommended where poisons seem inadvisable, and it is the preferred method for areas where only a few rodents are present.

Trapping has several advantages:

1. It does not rely on hazardous rodenticides.
2. It permits the user to observe the effectiveness.
3. It allows for disposal of rodent carcasses, thereby eliminating odor problems that occur.

Snap traps are generally more effective than cage traps. For rats, bait the traps with peanut butter, chocolate

candy, dried fruit, or a small piece of bacon tied securely to the trigger. For mice, use bacon, nuts, hard sugar candy, gumdrops, or peanut butter. Leaving traps unset until the bait has been taken at least once reduces the chance of rats or mice becoming trap shy.

Place the traps so that the rats and mice following their natural course of travel will pass directly over the trigger. Use enough traps to make the campaign short and decisive. Since mice seldom venture far from their shelter and food supply, traps should be placed from 3 to 10 feet apart in areas where mouse activity is noted. Place traps within 20 feet of each other for rats.

Glueboards

Glueboards are an alternative to traps. Glueboards catch and hold mice and rats that step on surface. Like traps, glueboards need to be placed along the travel path of mice and rats. Glueboards should not be used where children, pets, or desirable wildlife can come in contact. Glueboards lose their effectiveness in dusty areas and temperature extremes may affect the tackiness of the adhesive.

LEGAL STATUS

The domestic or commensal rodents discussed in this section of the manual are not protected by federal law and are not protected in Utah. Special caution should be taken when poisoning rodents in locations where other animals are likely to come in contact with the rodenticide.

VI. WORKER PROTECTION STANDARD

The U.S. Environmental Protection Agency's Worker Protection Standard (WPS), as revised in 1992, must be complied with when pesticides are used on agricultural establishments, including farms, forests, nurseries, and greenhouses, for the commercial or research production of agricultural plants. The WPS requires employers to provide agricultural workers and pesticide handlers with protections against possible harm from pesticides. Persons who must comply with these instructions include owners or operators of agricultural establishments and owners or operators of commercial businesses that are hired to apply pesticides on the agricultural establishment or to perform crop-advising tasks on such establishments. Family members who work on an agricultural or commercial pesticide establishment are considered employees in some situations.

WPS requirements for employers include:

- **Displaying information** about pesticide safety, emergency procedures, and recent pesticide applications on agricultural sites.
- **Training** workers and handlers about pesticide safety.
- Helping employees get **medical assistance** in case of a pesticide related emergency.
- Providing **decontamination sites** to wash pesticide residues off hands and body.
- Compliance with **restricted entry intervals (REI)** – the time after a pesticide application when workers may not enter the area.
- **Notifying** workers through posted and/or oral warnings about areas where pesticide applications are taking place and areas where REI are in effect.
- Allowing only **trained and equipped workers** to be present during a pesticide application.
- Providing **personal protective equipment (PPE)** for pesticide handlers and also for workers who enter pesticide treated areas before expiration of the REI.
- **Protecting pesticide handlers** by giving them safety instructions about the correct use of pesticide application equipment and PPE and monitoring workers and handlers in hazardous situations.

One of the provisions of the WPS is the requirement that employers provide handlers and workers with ample water, soap, and single use towels for washing and decontamination from pesticides and that emergency transportation be made available in the event of a pesticide poisoning or injury. The WPS also establishes REI and the requirements for PPE. PPE requirements are specified for all pesticides used on farms and in forests, greenhouses, and nurseries. Some pesticide products already carried REI and PPE directions. This rule raised the level of protection and requirements for all pesticide products.

Other major provisions require that employers inform workers and handlers about pesticide hazards through safety training. Handlers must have easy access to pesticide label safety information and a listing of treatment sites must be centrally located at the agricultural facility. Handlers are prohibited from applying a pesticide in a way that could expose workers or other people.

References: *The Worker Protection Standard for Agricultural Pesticides–How to Comply: What Employers Need to Know*. Web site <www.usda.gov/oce/oce/labor-affairs/wpspage.htm>.

VI. PROTECTING GROUNDWATER AND ENDANGERED SPECIES

INTRODUCTION

Federal and state efforts to protect groundwater and endangered species have resulted in special requirements and restrictions for pesticide handlers and applicators. Pesticides that are incorrectly or accidentally released into the environment can pose a threat to groundwater and endangered species. Whether pesticides are applied indoors or outdoors, in an urban area or in a rural area, the endangered species and groundwater must be protected and state and federal agencies rigidly enforce this requirement.

The need for special action by the pesticide handler/applicator depends on site location. Groundwater contamination is of special concern in release sites where groundwater is close to the surface or where the soil type or the geology allows contaminants to reach groundwater easily. In the case of endangered species, special action is normally required in locations where the species currently live or in locations where species are being reintroduced. The product labeling is the best source to determine if pesticide use is subject to groundwater or endangered species limitations.

The U.S. Environmental Protection Agency (EPA) establishes the specific limitations or instructions for pesticide users in locations where groundwater or endangered species are most at risk. These limitations and instructions may be too detailed for inclusion in pesticide labeling. In such cases the labeling will direct the applicator or handler to another source for instructions and restrictions. The legal responsibility for following instructions that are distributed separately is the same as it is for instructions that appear on the pesticide labeling.

PROTECTING GROUNDWATER

Groundwater is water located beneath the earth's surface. Many people think that groundwater occurs in vast underground lakes, rivers, or streams. Usually, however, it is located in rock and soil. It moves very slowly through irregular spaces within otherwise solid rock or seeps between particles of sand, clay, and gravel. An exception is in limestone areas, where groundwater may flow through large underground channels or caverns. Surface water may move several feet in a second or a minute. Groundwater may move only a few feet in a month or a year. If the groundwater is capable of providing significant quantities of water to a well or spring, it is called an aquifer. Pesticide contamination of aquifers is very troubling, because these are sources of drinking, washing, and irrigation water.

Utah has implemented a comprehensive and coordinated approach to protect groundwater from pesticide contamination. Formulation of the Utah Groundwater and Pesticide State Management Plan is a cooperative effort between federal, state, private agencies, producers, and user groups. It provides

a basis for continuing future efforts to protect groundwater from contamination whenever possible. Furthermore, this plan provides agencies with direction for management policies, regulations, enforcement, and implementation of groundwater strategies.

Utah recognizes that the responsible and wise use of pesticides can have a positive economic impact, yield a higher quality of life, enhance outdoor activities, and give relief from annoying pests. The EPA has authorized the Utah Department of Agriculture and Food (UDAF) to enforce the protection of groundwater from pesticides.

The UDAF, in concert with cooperating agencies and entities, demands strict compliance with all pesticide labels, handling procedures, and usage to protect groundwater in the state.

Prevention of groundwater contamination is important, because once the water is polluted, it is very difficult and costly to correct the damage and in some instances impossible. City and urban areas contribute to pollution because water runoff can contain pesticides. Shallow aquifers or water tables are more susceptible to contamination than deeper aquifers or water tables. Sandy soils allow more pollution to move than clay or organic soils, because clays and organic matter adsorb many of the contaminants. For more information about what groundwater is and where it comes from, read the study manual ***Applying Pesticides Correctly: A Guide for Private and Commercial Applicators.***

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, establishes a policy for determining the acceptability of a pesticide use or the continuation of that use, according to a risk/benefit assessment. As long as benefits outweigh adverse effects, the EPA can continue to register the pesticide. Although the intent of a pesticide application is to apply the pesticide to the target or pest, part of the pesticide will fall on the area around the target or pest. Rain or irrigation water then can pick up the part that is not degraded or broken down and carry it to the groundwater via leaching.

There are many factors that influence the amount of pesticide contamination that can get into groundwater. The major factors are the soil type, soil moisture, persistence in soil, placement of the pesticide, frequency of application, pesticide concentration and formulation, pesticide water solubility, and precipitation. Each of these factors will influence the amount of pesticide that can penetrate the soil surface, leave the root zone, and percolate into groundwater.

Although some pesticides may have a high adsorption quality, when they are applied to sandy soil, they may still migrate to the water table because there are few clay particles or little organic matter to bind them. The management and use of pesticides is up to the individual applicator and/or landowner as to whether safe practices are used. Groundwater is a very valuable resource and it must be protected from pesticide contamination.

PROTECTING ENDANGERED SPECIES

The Federal Endangered Species Act lists the three classifications as endangered, threatened, and experimental. Endangered has the highest level of protection. The phrase “endangered species” is used when referring to these classifications. This Act was passed by Congress to protect certain plants and wildlife that are in danger of becoming extinct. A portion of this Act requires EPA to ensure that these species are protected from pesticides.

EPA’s goal is to remove or reduce the threat to endangered species that pesticides pose. Achieving this goal is a portion of the larger continuing effort to protect species at risk. Normally these restrictions apply to the habitat or range currently occupied by the species at risk. Occasionally the restrictions apply where endangered species are being reintroduced into a habitat previously occupied.

Habitats are the areas of land, water, and air space that an endangered species needs for survival. Such areas include breeding sites, sources of food, cover, and shelter, and the surrounding territory that provides space for normal population growth and behavior.

Utah’s endangered species plan is a cooperative effort between federal, state, private agencies, producers, and user groups. This plan provides agency direction for regulations, enforcement, management policies, and implementation of threatened and endangered species protection strategies.

EPA launched a major project known as Endangered Species Labeling (ESL). The goal is to remove or reduce the threat to endangered species from pesticides. EPA has the responsibility to protect wildlife and the environment against hazards posed by pesticides. The ESL program is administered by the U.S. Fish and Wildlife Service (FWS) in the U.S. Department of Interior. The FWS reports to EPA concerning endangered species. EPA and FWS work cooperatively to ensure that there is consistency in the pesticide restriction information provided to agencies and pesticide users.

The UDAF acts under the direction and authority of EPA to carry out the ESL project as it relates to the use of pesticides in Utah. Utah’s web sites with maps designating the habitat boundaries and listings of endangered plants and wildlife is: www.utahcdc.usu.edu

VII. CALIBRATION INFORMATION

Conversion:

Units

One acre = 43,560 square feet

One mile = 5,280 feet

One gallon = 128 fluid ounces

One quart = 2 pints = 4 cups = 32 fluid ounces

One pint = 2 cups = 16 fluid ounces
ounces

One tablespoon = 3 teaspoons = 0.5 fluid ounces
ounce

One pound = 16 ounces

One gallon = 231 cubic inches
inches

Example: $\frac{1}{2}$ acre = 21,780 square feet

Example: $\frac{1}{4}$ mile = 1320 feet

Example: $\frac{1}{2}$ gallon = 64 fluid ounces

Example: 2 quarts = 64 fluid ounces

Example: $\frac{1}{2}$ pint = 1 cup = 8 fluid

Example: 2 tablespoons = 1 fluid

Example: $\frac{1}{4}$ pound = 4 ounces

Example: 2 gallons = 462 cubic

Weights

1 ounce = 28.35 grams

16 ounces = 1 pound = 453.59 grams

1 gallon water = 8.34 pounds = 3.785 liters = 3.78 kilograms

Liquid Measures

1 fluid ounce = 2 tablespoons = 29.573 milliliters

16 fluid ounces = 1 pint = 0.473 liters

2 pints = 1 quart = 0.946 liters

8 pints = 4 quarts = 1 gallon = 3.785 liters

Lengths

1 foot = 30.48 centimeters

3 feet = 1 yard = 0.9144 meters

16 $\frac{1}{2}$ feet = 1 rod = 5.029 meters

5280 feet = 320 rods = 1 mile = 1.6 kilometers

Areas

1 square foot = 929.03 square centimeters

9 square feet = 1 square yard = 0.836 square meters

43560 square feet = 160 square rods = 1 acre = 0.405 hectares

Speeds

1.466 feet per second = 88 feet per minute = 1 mph = 1.6 kilometers per hour (kHz)

Volumes

27 cubic feet = 1 cubic yard = 0.765 cubic meters

1 cubic foot = 7.5 gallons = 28.317 cubic decimeters

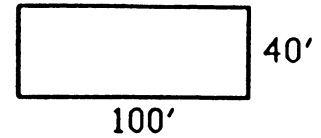
Area and Volume Calculations:

Area of Rectangular or Square Shapes

The area of a rectangle is found by multiplying the length (L) times the width (W).

$$(\text{Length}) \times (\text{Width}) = \text{Area}$$

Example: (100 feet) x (40 feet) = 4000 square feet

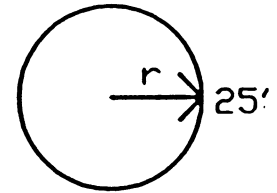


Area of Circles

The area of a circle is the radius (radius = one-half the diameter), times the radius, times 3.14.

$$(\text{radius}) \times (\text{radius}) \times (3.14) = \text{Area}$$

Example: (25 feet) x (25 feet) x (3.14) = 1962.5 square feet

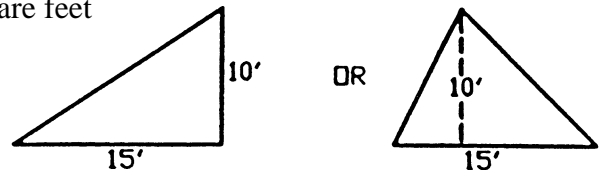


Area of Triangular Shapes

To find the area of a triangle, multiply $\frac{1}{2}$ times the width of the triangle's base, times the height of the triangle.

$$(\frac{1}{2}) \times (\text{base width}) \times (\text{height}) = \text{Area}$$

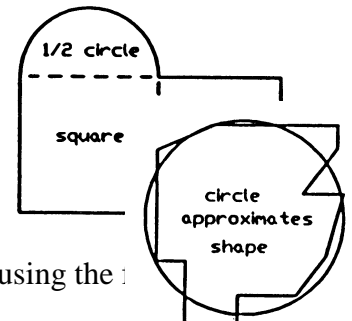
Example: $(\frac{1}{2}) \times (15 \text{ feet}) \times (10 \text{ feet}) = 75 \text{ square feet}$



Area of Irregular Shapes

Irregularly shaped sites can often be reduced to a combination of rectangles, circles, and triangles. Calculate the area of each shape and add the values together to obtain the total area.

Example: Calculate the area of the rectangle, triangle, square and one-half of a circle.



Another method is to convert the site into a circle. From a center point, measure the distance to the edge of the area in 10 or more increments. Average these measurements to find the radius, and then calculate the area using the formula for a circle.

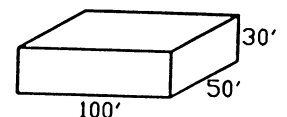
Example: Approximate the area by calculating the area of a similarly sized circle.

Volume of Cube and Box Shapes

The volume of a cube or box is found by multiplying the length, times the width, times the height.

$$(\text{Length}) \times (\text{Width}) \times (\text{Height}) = \text{Volume}$$

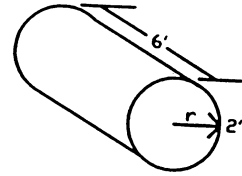
Example: (100 feet) x (50 feet) x (30 feet) = 150,000 cubic feet



Volume of Cylindrical Shapes

The volume of a cylinder is found by calculating the area of the round end (see formula for circle) and multiplying this area times the length or height.

Example: (radius) x (radius) x (3.14) = Area of Circle
(Area of Circle) x (Length) = Volume of Cylinder
(2 feet) x (2 feet) x (3.14) x (6 feet) = 75.36 cubic feet



Sprayer Calibration Formulas:

To Calculate Travel Speed in Miles Per Hour

The travel speed of a sprayer is determined by measuring the time (seconds) required to travel a known distance (such as 200 feet). Insert the values in the following formula to determine the miles per hour.

$$\frac{\text{Distance in Feet} \times 60}{\text{Time in Seconds} \times 88} = \text{Miles Per Hour}$$

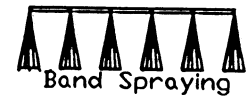
$$\text{Example: } \frac{(200 \text{ feet}) \times (60)}{(30 \text{ seconds}) \times (88)} = \frac{12,000}{2640} = 4.55 \text{ mph}$$

To Calculate the Gallons Per Minute Applied During Broadcast Spraying

The application rate in gallons per minute (GPM) for each nozzle is calculated by multiplying the gallons per acre (GPA), times the miles per hour (MPH), times the nozzle spacing in inches (W); then dividing the answer by 5940. For small adjustments in GPM sprayed, operating pressure is changed. For large adjustments in GPM sprayed, travel speed (miles per hour) is changed or nozzle size is changed.

$$\frac{\text{GPA} \times \text{MPH} \times \text{W}}{5940} = \text{GPM}$$

$$\text{Example: } \frac{(12 \text{ GPA}) \times (4.5 \text{ MPH}) \times (24'')}{5940} = \frac{1296}{5940} = 0.22 \text{ GPM}$$



To Calculate the Gallons Per Minute Applied During Band Spraying

Broadcast spraying applies chemicals to the entire area. Band spraying reduces the amount of area and chemicals sprayed per acre. To use the above formulas for band sprayer applications, use the band width (measured in inches) rather than nozzle spacing for the "W" value.

Pesticide Mixing:

Terminology

The ***active ingredients*** of a pesticide are the chemicals in a formulation that control the target pests. The ***formulation*** is the pesticide product as sold, usually a mixture of concentrated active ingredients and an inert material. Restricted use pesticides are purchased in formulations requiring ***dilution prior to application***. Formulations are diluted with inert substances such as water. The ***percentage of active ingredients*** in a pesticide formulation directly affects dilution and application rates. Given two pesticides, A = 50% active ingredients, B = 100% active ingredients; twice as much pesticide A formulation is required to equal pesticide B formulation.

To Determine the Total Amount of Pesticide Formulation Required Per Tank

To calculate the total amount of pesticide formulation needed per spray tank, multiply the recommended dilution, ounces/pints/cups/teaspoons/tablespoons/etc. of pesticide per gallon of liquid, times the total number of gallons to be mixed in the sprayer. A full or partial tank of pesticide spray may be mixed.

(Dilution Per Gallon) x (Number of Gallons Mixed) = Required Amount of Pesticide

Formulation Example: (3 ounces per gallon) x (75 gallons) = 225 ounces

Note: 1 gallon = 128 ounces; through unit conversion 225 ounces = 1.76 gallons

To Calculate the Amount of Pesticide Formulation Sprayed Per Acre

The calculate the total amount of pesticide formulation sprayed per acre is determined by multiplying the quantity of formulation (ounces/pounds/pints/cups/teaspoons/tablespoons/etc.) mixed per gallon of water, times the number of gallons sprayed per acre.

(Quantity of Formulation Per Gallon) x (Gallons Sprayed Per Acre) = Formulation Sprayed Per Acre

Example: (1/2 pound per gallon) x (12 gallons per acre) = 6 pounds per acre

To Calculate the Amount of Active Ingredients Sprayed Per Acre

The total amount of active ingredients (AI) applied per acre, multiply the amount (pounds, gallons, ounces, etc) of pesticide formulation required per acre, times the percentage of active ingredients in the formulation (100%, 75%, 50%, 25%, etc.), and divide the value by 100.

$$\frac{(\text{Amount of Formulation Required Per Acre}) \times (\text{Percentage of AI})}{100} = \text{Active Ingredients Per Acre}$$

Example:
$$\frac{(4 \text{ pounds formulation sprayed per acre}) \times (75\% \text{ AI})}{100} = 3 \text{ pounds of AI sprayed per acre}$$

Note: 75 % = 0.75

To Calculate the Gallons of Pesticide Mixture Sprayed Per Acre

The total amount of pesticide mixture sprayed per acre is determined by dividing the number of gallons sprayed by the number of acres sprayed.

Gallons Sprayed = Gallons Sprayed Per Acre

Acres Sprayed

Example:
$$\frac{200 \text{ Gallons Sprayed}}{10 \text{ Acres Sprayed}} = 20 \text{ gallons of pesticide mixture sprayed per acre}$$

GLOSSARY

A

ACTIVE INGREDIENT - The chemical(s) in a pesticide responsible for killing, poisoning, or repelling the pest.
ACUTE TOXICITY - Injury within 24 hours following exposure.
ANTICOAGULANT - A chemical that prevents normal blood clotting.
ANTIDOTE - A treatment to counteract the effects of poisoning.
ATTRACTANT - A substance or device that will lure pests to a trap or poison bait.
AVICIDE - A pesticide used to kill or repel birds.

B

BACTERIA - Microscopic organisms, some of which are capable of producing diseases in plants and animals.
BAIT - A food or other substance used to attract a pest to a pesticide or trap.
BIOLOGICAL CONTROL - Control of pests by means of predators, parasites, disease-producing organisms or competitive microorganisms.

CHRONIC TOXICITY - Injury or illness beyond 24 hours following exposure due to prolonged or repeated exposure.
CONCENTRATION - The amount of active material in a given volume of diluent.
CONTACT REPELLENT - A compound that the pest must make contact with for the substance to repel pest.
CONTAMINATION - The presence of an unwanted substance in or on plants, animals, soil, water, air, or structures.
CULTURAL CONTROL - A pest control method that includes changing sanitation and/or work practices.

D

DECONTAMINATE - To remove or break down a chemical from a surface or substance.
DERMAL TOXICITY - Injury when absorbed through the skin.
DOSE OR DOSAGE - Amount or rate of chemical applied to a given area or target.

E

ECOSYSTEM - The physical and biotic factors that allow infestation by pests.
ECTOPARASITE - A parasite that lives on the outside of its host.
ENDANGERED SPECIES - Legally classified as a species in danger of extinction.
ENDOPARASITE - A parasite that lives inside its host.
ERADICATION - Pest management strategy that attempts to eliminate all members of a pest species.
EXPOSURE ROUTE - The dermal, oral, or inhalation (respiratory) route by which a substance may enter an organism.
EXOTHERMIC - Chemical reaction that produces heat.

F

FORMULATION - Pesticide as prepared by the manufacturer.
FUMIGANT - Pesticide that controls by giving off fumes.

G

GROUNDWATER - Water sources located beneath the soil surface from which water is obtained.

H

HARBORAGE - A site that shelters and provides the food and water required for a particular organism to survive.
HOST - Plant or animal that is invaded by a parasite and from which the parasite gets its nutrients.

I

INERT INGREDIENT - In a pesticide formulation it is an inactive material without pesticidal activity.
INHALATION TOXICITY - Injury when inhaled.
INTEGRATED PEST MANAGEMENT (IPM) - A planned pest control program in which various techniques are used to keep pests from causing economic, health related, or aesthetic injury.

L

LEACHING - Process by which some pesticides move through the soil.

LEGAL STATUS - Classified such that it is permitted or allowed by law.

LETHAL - Causing or able to cause death.

N

NONLETHAL – Not capable of causing death.

NONTARGET ORGANISM - Any plant or animal other than the intended target of a pesticide application.

O

ORAL TOXICITY – Injury when taken by mouth.

P

PARASITE - An organism that lives on or in a living host and that gets all or part of its nutrients from the host.

PATHOGEN - Any organism capable of causing disease.

PHYTOTOXICITY - Injury to plants by a chemical.

PREDATOR - An animal that attacks, kills, and feeds on other animals.

PROTECTED STATUS - Legally classified as a species in danger of extinction.

R

RATE OF APPLICATION - The amount of pesticide applied, usually measured as per acre, per 1,000 square feet, per linear foot, or per cubic foot.

RE-ENTRY INTERVAL - The length of time following an application of a pesticide when entry into the areas is restricted.

REPELLENT - A compound that keeps pests away.

RISK - A probability of an adverse effect in a given situation.

RODENTICIDE - A pesticide used to control rodents.

S

SIGNAL WORDS - Required word(s) that appear on every pesticide label to denote the relative acute toxicity of the product. SURFACE WATER - Water on the earth's surface in rivers, lakes, ponds, streams, etc.

T

TARGET - The plants, animals, structures, areas, or pests at which the pesticide or other control method is directed.

TOXIC - Poisonous to living organisms.

TOXICITY - The degree or extent to which a chemical or substance is poisonous.

U

UNPOTECTED STATUS - Not classified as a species in danger of extinction.

V

VECTOR - An animal that can carry and transmit a pathogen.

VERTEBRATE ANIMAL- Animal with a segmented backbone and spinal column.

VIRUS - Ultramicroscopic parasites that can multiply only in living tissues and cause many animal and plant diseases.

W

WATER TABLE - The upper level of the water saturated zone in the ground.